Canyon Fuel Company, LLC
A Subsidiary of Wolverine Fuels Holding, LLC

**Sufco Mine**
John D. Byars
General Manager
397 South 800 West
Salina, Utah 84654
(435) 286-4400
Fax (435) 286-4499

April 22, 2020

Permit Supervisor, Utah Regulatory Program
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, UT 84114-5801

Re: Fossil Rock Permit Revisions, Canyon Fuel Company, LLC, Fossil Rock Mine, C/015/0009

Dear Sirs:

Enclosed with this letter is a copy of revision to information in the Fossil Rock Permit. Per a request by the Division the information from the existing permit has been revised to follow the sequence of the regulations. Confidential information has been collected from the Deer Creek permit and other sources and compiled into a "Confidential Binder".

The revisions have required extensive movement of text, tables, figures, maps and appendices for Chapters 1, 2, 3, 4, and 5. Chapters 8 and 9 in the currently approved permit have been removed and replaced with a bonding chapter and an alluvial valley floor chapter. Chapters 6 and 7 have been revised. Plates have been revised; several have been added while others have been removed.

Once the Division staff has had a cursory review of the documents, it may be helpful to have a meeting with the permittee to allow questions to be asked and answered. If the Division determines a meeting would be helpful if they would contract the permittee with some suggested dates for a meeting.

Please contact Vicky Miller by e-mail (vmiller@wolverinefuels.com) if there are questions or additional information is needed.

Sincerely,

Vicky A Miller for

John D. Byars
General Manager
Sufco Coal Mine

Encl.

Cc: DOGM Correspondence File

# APPLICATION FOR COAL PERMIT PROCESSING

Permit Change X New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐

**Permittee:** Canyon Fuel Company, LLC
**Mine:** Fossil Rock Mine **Permit Number:** C/015/0009
**Title:** Fossil Rock Permit Text, Table, Appendix, and Plate Revisions
**Description,** Include reason for application and timing required to implement:

**Instructions:** If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

☐ Yes X No 1. Change in the size of the Permit Area? Acres: _____ Disturbed Area: _____ ☐ increase ☐ decrease.
☐ Yes X No 2. Is the application submitted as a result of a Division Order? DO# _____
☐ Yes X No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes X No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes X No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes X No 6. Does the application require or include public notice publication?
☒ Yes No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☒ Yes No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes X No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes X No 10. Is the application submitted as a result of other laws or regulations or policies?
*Explain*: _____
☐ Yes X No 11. Does the application affect the surface landowner or change the post mining land use?
☒ Yes No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☒ Yes No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes X No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☐ Yes X No 15. Does the application require or include soil removal, storage or placement?
☐ Yes X No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes X No 17. Does the application require or include construction, modification, or removal of surface facilities?
☒ Yes No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☒ Yes No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes X No 20. Does the application require or include subsidence control or monitoring?
☒ Yes No 21. Have reclamation costs for bonding been provided?
☐ Yes X No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes X No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

**Please attach one (1) review copy of the application.**

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

WAYNE SQUIRE — Print Name
Wayne Squire DIRECTOR of HR 4/22/20 — Sign Name, Position, Date

Subscribed and sworn to before me this 22nd day of April, 2020

Jill White — Notary Public

My commission Expires: 3/28, 2024
Attest: State of Utah } ss:
County of Sevier

JILL WHITE
Notary Public
State of Utah
My Commission Expires 03/28/2024
COMMISSION NUMBER 711129

| For Office Use Only: | Assigned Tracking Number: | Received by Oil, Gas & Mining |
|---|---|---|
| | | |

# APPLICATION FOR COAL PERMIT PROCESSING
## Detailed Schedule Of Changes to the Mining And Reclamation Plan

**Permittee:** Canyon Fuel Company, LLC
**Mine:** Fossil Rock Mine **Permit Number:** C/015/0009
**Title:** Fossil Rock Permit Text, Table, Appendix, and Plate Revisions

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

| | | | DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED |
|---|---|---|---|
| ☐ Add | ☐ Replace | ☐ Remove | M & RP |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 1 |
| ☒ Add | ☐ Replace | ☐ Remove | Appendix 1-1 and Appendix 1-2 |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 2, Text & Tables |
| ☒ Add | ☐ Replace | ☐ Remove | Appendix 2-1, 2-8-1, 2-8-1(L), 2-8-2, 2-8-2(L), 2-8-3, 2-8-4 |
| ☒ Add | ☐ Replace | ☐ Remove | Plate 2-1 |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 3, Text, Tables and Figures |
| ☒ Add | ☐ Replace | ☐ Remove | Plates 3-1, 3-2, 3-4, 3-5, 3-6 |
| ☒ Add | ☐ Replace | ☐ Remove | Appendix 3-9-1, 3-9-2, 3-10-1, 3-10-2, 3-10-3, 3-10-4, 3-10-5, 3-10-6, 3-10-7, 3-10-8L |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 4 |
| ☒ Add | ☐ Replace | ☐ Remove | Plates 4-1, 4-2, 4-3 |
| ☒ Add | ☐ Replace | ☐ Remove | Appendix 4-1, 4-3 |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 5, Text, Tables and Figures |
| ☒ Add | ☐ Replace | ☐ Remove | Plates 5-1, 5-2, 5-3, 5-4, 5-5, 5-7, 5-8, 5-9, 5-10, 5-11, 5-12, 5-13, 5-14A, 5-14B, 5-15, 5-16 |
| ☒ Add | ☐ Replace | ☐ Remove | Appendix 5-1**, 5-2, 5-3, 5-3-1, 5-4, 5-5, 5-6, 5-7, 5-8, 5-9, 5-10, 5-11, 5-11-1, 5-11-2, 5-11-3, 5-11-4, 5-11-5 |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 6, Text, Tables and Figures |
| ☐ Add | ☒ Replace | ☐ Remove | Plates 6-1, 6-2, 6-3, 6-4, 6-5 |
| ☐ Add | ☒ Replace | ☐ Remove | Appendix 6-1 and 6-2 |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 7, Text, Tables and Figures |
| ☐ Add | ☒ Replace | ☐ Remove | Plates 7-1, 7-2, 7-3, 7-4, 7-5 |
| ☐ Add | ☒ Replace | ☐ Remove | Appendix 7-1**, 7-3, 7-4, 7-5, 7-6, 7-7, 7-8, 7-9, 7-10**, 7-11, 7-12, 7-13, 7-14, 7-14(L), 7-15(L), 7-16, 7-17, 7-18 |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 8 |
| ☐ Add | ☒ Replace | ☐ Remove | Chapter 9 |
| ☐ Add | ☐ Replace | ☒ Remove | Chapters 10, 11 |
| ☐ Add | ☐ Replace | ☒ Remove | Plates 7-5 thru 7-11 |
| ☐ Add | ☐ Replace | ☐ Remove | CONFIDENTIAL |
| ☒ Add | ☐ Replace | ☐ Remove | Raptor Survey Data and Appendix 4-1## |
| ☐ Add | ☐ Replace | ☐ Remove | |

**Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.**

**All appendices are currently scanned except for revised Appendix 5-1, 7-1 and 7-10 which are attached. These attached appendices will replace those previously scanned.
## The information listed for inclusion into the confidential folder/binder has been previously scanned.

April 22, 2020

**Received by Oil, Gas & Mining**

# CHAPTER 1

# GENERAL CONTENTS

## TABLE OF CONTENTS

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## LIST OF APPENDICES

| Appendix | Description |
|---|---|
| 1-1 | Special Warranty Deeds, Leases, Right -of Entry Documents (Formerly Appendix 4-1, 4-2 and 4-4 |
| 1-2 | Newspaper Advertisements |

Yellow highlight signifies Text/Information Previously in Approved DOGM Permit, Moved and incorporated into Chapter 1. Red text within the yellow highlight is revised text. The un-highlighted text is new information being added to the permit document.

# CHAPTER 1
# GENERAL CONTENTS

## 110 Minimum Requirements for Legal, Financial, Compliance and Related Information

### 111 Introduction

For information pertaining to this section(s) refer to the General Chapter 1 binder for Canyon Fuel Company, LLC prepared for the Fossil Rock Mine, Dugout Canyon Mine, Soldier Canyon Mine, SUFCO Mine, Skyline Mines, Banning Loadout and other operations.

### 112 Identification of Interests

#### 112.100 Business Entity

Fossil Rock Resources, LLC is a Limited Liability Company organized under the laws of Delaware on August 29, 2014 and is owned 100% by Canyon Fuel Company, LLC.

For additional information pertaining to this section(s) refer to the General Chapter 1 binder for Canyon Fuel Company, LLC prepared for the Fossil Rock Mine, Dugout Canyon Mine, Soldier Canyon Mine, SUFCO Mine, Skyline Mines, Banning Loadout and other operations.

### 112.200 Applicant and Operator

For information pertaining to this section(s) refer to the General Chapter 1 binder for Canyon Fuel Company, LLC prepared for the Fossil Rock Mine, Dugout Canyon Mine, Soldier Canyon Mine, SUFCO Mine, Skyline Mines, Banning Loadout and other operations.

### 112.300 Control Persons

For information pertaining to this section(s) refer to the General Chapter 1 binder for Canyon Fuel Company, LLC prepared for the Fossil Rock Mine, Dugout Canyon Mine, Soldier Canyon Mine, SUFCO Mine, Skyline Mines, Banning Loadout and other operations.

### 112.400 Coal Mining and Reclamation Operation Permit Applications

Previous, Current or Pending - The following list describes permits held by Canyon Fuel Company, LLC, pending applications for permits, and permits recognized as necessary in the future for which no application has been filed. Identification numbers of applications or permits are contained in the following list. Many of the agencies listed, however, have review responsibility only and may not have submitted a numbered permit.

| Permit | Issuing Authority | Approval Status/ Identification No. |
|---|---|---|
| Mining and Reclamation Permit C/015/0009 | State of Utah<br>Department of Natural Resources<br>Division of Oil, Gas and Mining<br><br>Department of Interior<br>U.S. Geological Survey and<br>Office of Surface Mining | Approved |

| | | |
|---|---|---|
| | Department of Agriculture<br>U.S. Forest Service<br>Manti La Sal National Forest | |
| U.P.D.E.S. Permit<br>UT-0023728 | Environmental Protection Agency<br>and Utah D.E.Q. | Approved |
| ID No. 42-01211 | Mine Safety and Health<br>Administration – Utah | Mine<br>Approved |
| ID No. 42-02662 | Mine Safety and Health<br>Administration – Utah | Waste Rock Disposal<br>Approved |
| Air Quality<br>Approval Orders<br>DAQE-EN156760001-16 | State of Utah<br>Department of Health<br>Division of Environmental Health | Approved |
| Water Rights | State Engineer | Approved |

A table of the Canyon Fuel Company, LLC mining permits and operations is in General Chapter 1.

| | |
|---|---|
| Fossil Rock Mine | C/015/0009 |

The issuing authority for the Canyon Fuel Company, LLC permits is the UDOGM.

Operations held by Canyon Fuel Company, LLC and corporate structure are presented on Figure 1-1 in the General Chapter 1 for Canyon Fuel Company, LLC. Facility names, mailing addresses and permit numbers for these operations are provided in either Table 1-1 and/or Table 1-2. For additional information refer to the General Chapter 1 binder for Canyon Fuel Company, LLC.

## 112.500 Legal or Equitable Owner of the Surface and Mineral Properties

Owner of the surface under Federal Coal Leases UTU-49332, UTU-64375, UTU-82996 and (ROW) UTU-65027 are:

United States of America
Department of Agriculture
U.S. Forest Service
Manti-La Sal Forest
599 West Price River Drive
Price, Utah 84501

United States of America
Department of Interior
Bureau of Land Management
Price Coal Office
125 South 600 West
Price, Utah 84501

Lessee for the Federal Coal Leases and State of Utah Coal Lease is:

Canyon Fuel Company, LLC
9815 So. Monroe Street, Suite 203
Sandy, Utah 84070
Telephone: (801) 695-9107

The Bureau of Land Management owns the mineral rights for the Federal Coal Leases and the State of Utah owns the mineral rights for the State Coal Lease.

United States of America
Department of Interior
Bureau of Land Management
Price Coal Office

125 South 600 West
Price, Utah 84501

The Applicant owns 56.36 acres of surface and coal within the lease area. This surface and coal are owned by:

.

Fossil Rock Resources, LLC
9815 So. Monroe Street, Suite 203
Sandy, Utah 84070
Telephone: (801) 695-9107

A property ownership map of the permit area and adjacent area is presented as Plates 5-4. No area within the lands to be affected by surface operations and facilities or within the area of coal to be mined is under a real estate contract.

Coal mining and reclamation operations are listed on Table 1-1 and the corporate structures is presented on Figure 1-1 in the General Chapter 1 binder.

**112.600 Owners of Record of Property Contiguous to Proposed Permit Area**

The following list contains the names and addresses of owners of surface lands contiguous to the permit boundary:

United States of America
Department of Agriculture
U.S. Forest Service
Manti-La Sal National Forest
599 West Price River Drive
Price, Utah 84501

State of Utah
School and Institutional Trust Lands Administration

675 East 500 South, Suite 500
Salt Lake City, Utah 84102-2818

United States of America
Department of Interior
Bureau of Land Management
Price Coal Office
125 South 600 West
Price, Utah 84501

PacifiCorp
1407 West N. Temple, Suite 310
Salt Lake City, Utah 84116

The following list contains the names and addresses of the owners of mineral acreage contiguous to the permit boundary:

State of Utah
School and Institutional Trust Lands Administration
675 East 500 South, Suite 500
Salt Lake City, Utah 84102-2818

United States of America
Department of Interior
Bureau of Land Management
Price Coal Office
125 South 600 West
Price, Utah 84501

Pacificorp
1407 West N. Temple, Suite 310
Salt Lake City, Utah 84116

### 112.700 MSHA Numbers

Mine ID No. 42-00089, Waste Rock ID No. 1211-UT-09-00089-01.

### 112.800 Interest in Contiguous Lands

The applicant owns or controls, directly or indirectly, no legal or equitable interest in any lands contiguous to the permit area, with the exception of the SITLA Lease ML 51191 OBA and ML 51192 OBA.

## 112.900 Certification of Submitted Information

Canyon Fuel Company, LLC hereby attests that the information contained in this permit document is true and correct to the best of their knowledge.

## 113 Violation Information

For violation information refer to Table 1-2 in the General Chapter 1 binder for Canyon Fuel Company, LLC prepared for the operations.

## 114 Right-of-Entry Information

Fossil Rock Resources, LLC owns the fee land on which the surface facilities are located. The surface land was conveyed from PACIFICORP to Fossil Rock Resources, LLC by two Special Warranty Deeds (October 8, 2015). The Special Warranty Deeds are recorded in Emery County at entry numbers 410236 and 412586. The Special Warranty Deeds are presented in Appendix 1-1.

The right to enter the leaseholds conveyed by the Federal Coal Leases is conferred to the lessee by the Mineral Leasing Act of 1920 and the leases themselves. Copies of Federal Coal Leases UTU-49332, UTU-64375, UTU-082996, and (ROW) UTU-65027 which grant the right to enter and conduct underground mining operations on the leased premises are presented in Appendix 1-1.

The legal description of the Fossil Rock coal leases:

**Federal Leases**

Federal Coal Lease UTU-49332 - (380 acres +/-) - Assigned June 5, 2015

Assignment Approved by BLM August 13, 2015

T. 17 S., R. 6 E., SLM, Utah

Sec. 25, S1/2NW1/4, W1/2E1/2SW1/4, W1/2SW1/4

Sec. 26, SE1/4NE1/4, E1/2SW1/4NE1/4, E1/2SE1/4, E1/2W1/2SE1/4

Original Lease Acreage 641.47, Relinquished Acreage 261.47, Remaining Acreage 380 (2009)

Federal Coal Lease UTU-64375 - (260 acres +/-) - Assigned June 5, 2015

Assignment Approved by BLM August 13, 2015

T. 17 S., R. 6 E., SLM, Utah

Sec. 26, S1/2SW1/4, W1/2SW1/4SE1/4

Sec. 27, S1/2S1/2

Original Lease Acreage 2764.01, Relinquished Acreage 2504.01, Remaining Acreage 260 (2009)

Federal Coal Lease UTU-82996 - (80 acres +/-) - Assigned June 5, 2015

Assignment Approved by BLM August 13, 2015

T. 17 S., R. 6 E., SLM, Utah

Sec. 25, E1/2E1/2SW1/4, SW1/4SE1/4

Sec. 16, E2, SW4, S2NW4, NW4NW4

**Right-of Way (Waste Rock Site)**

BLM Right-of-Way UTU-65027 - (25.85 acres +/-) - Assigned by BLM August 17, 2015

Expires June 7, 2025

T. 17 S., R. 7 E., SLM

Sec. 34, SE1/4NE1/4, N1/2SE1/4, SW1/4SE1/4

Surveyed Legal Description

Township 17 South, Range 7 East, SLM

Section 34: Beginning at point N82$^0$ 39'28'W, 809.58 feet from the east 1/4 corner of Sec. 34; thence, S 74$^0$ 09' 46" W, 246.23 feet; thence, S 27$^0$ 14' 28" W, 647.59 feet; thence, S 46$^0$ 59' 05" W, 165.64 feet; thence, S 76$^0$ 41' 51" W, 264.72 feet; thence, N 72$^0$ 09' 12" W, 670.20 feet; thence, S 06$^0$ 10' 47" W, 105.57 feet; thence, S 23$^0$ 08' 12" W, 35.27 feet; thence, S 36$^0$ 59' 41"W, 71.59 feet; thence, S 40$^0$ 44' 45" W, 114.04 feet; thence, S 23$^0$ 37' 34" W, 93.77 feet; thence, S 60$^0$ 40' 32" W, 113.86 feet; thence, S 05$^0$ 17' 52" E, 108.19 feet; thence, S 23$^0$ 20' 37" E, 105.29 feet; thence, S 24$^0$ 38' 51" W, 61.70 feet; thence, S 31$^0$ 19' 19" E, 129.90 feet; thence, S29$^0$ 19' 58" E, 80.45 feet; thence, S 24$^0$ 11' 44" E, 104.97 feet; thence, S

47$^0$ 47' 54" E, 168.95 feet; thence, S 40$^0$ 17' 54" E, 87.31 feet; thence, S 17$^0$ 50' 49" W, 43.32 feet; thence, S 72° 11' 49" E, 213.13 feet; thence, S 78$^0$ 08' 28" E, 287.64 feet; thence, N 11$^0$ 43' 23" E, 86.24 feet; thence, N 73$^0$ 40' 14" E, 120.87 feet; thence, N 17$^0$ 04' 33" E, 74.31 feet; thence, N 14$^0$ 20' 36" W, 65.70 feet; thence, N 17$^0$ 05' 06" E, 75.21 feet; thence, N 09$^0$ 13' 24" W, 65.92 feet; thence, N 12$^0$ 54' 35" W, 99.73 feet; thence, N 02$^0$ 44' 30" W, 82.47 feet; thence, N 08$^0$ 32' 17" W, 85.51 feet; thence, N 01$^0$ 39' 36" W, 104.82 feet; thence, N 17$^0$ 50' 48" E, 218.03 feet; thence, N 76$^0$ 41' 51" E, 353.88 feet; thence, N 27$^0$ 14' 28" E, 629.52 feet; thence, N 50$^0$ 42' 06" E, 123.74 feet; thence, N 74$^0$ 09' 48" E, 113.70 feet; thence, N 15$^0$ 50' 13" W, 150.00 feet; to the point of beginning. Said parcel contains 25.85 acres more or less.

**Fee Property**

Special Warranty Deed (Parcel L3-11-1) (53.5 +/- acres)

Beginning at the Southwest corner of the Northwest quarter of the Southeast quarter of Section 25, Township 17 South, Range 6 East, SLB&M: thence North 160 rods; thence East 44 roads, more or less, to the center line of Cottonwood Creek; thence East 44 rods, more or less to the centerline of said Cottonwood Creek to a point 76 rods, more or less East of beginning; thence West 76 rods more or less to the point of beginning.

Special Warranty Deed (Parcel L3-011-0003) (2.86 +/- acres)

Beginning at a point which is West, 116 Rods, more of less from the Northeast corner of the South East quarter of the Northeast quarter of Section 25, Township 17 South Rand 6 East SLB&M. See Appendix 1-1 for a more complete legal description.

| **Leases** | **Right of Entry Acres** | **Total (Acres)** |
|---|---|---|
| Federal Surface | 720 | |

| | | |
|---|---|---|
| Private Surface | 56.36 | |
| BLM Right-of-Way | 25.85 | |
| | | **802.21** |
| | | |

The following legal description of the permit area reduces the acreage by 0.74 acres since the permit area will permanently reside on the western edge of the county road as opposed to the center line of the public road which is the fee coal and surface property line.

Legal description of the mine site permit area leased and fee:

T. 17 S., R. 6 E., SLM, Utah

Sec 16, E1/2, SW1/4, S1/2NW1/4, NW1/4NW1/4

Sec 25, S1/2NW14, SW1/4, SW1/4SE1/4, W1/2NW1/4SE1/4, W1/2SW1/4NE1/4, Portions of E1/2NW1/4SE1/4, E1/2SW1/4NE1/4 and area lying west of the west edge of Cottonwood Canyon Road

Sec 26, SE1/4NE1/4, E1/2SW1/4NE1/4, E1/2SE1/4, E1/2W1/2SE1/4, S1/2SW1/4, W1/2SW1/4SE1/4

Sec 27, S1/2S1/2

Legal description of the waste rock site permit area leased:

T. 17 S., R. 7 E., SLM, Utah

Sec. 34, Portions of SE1/4NE1/4, N1/2SE1/4, SW1/4SE1/4

The mining affected area, which is shown on Plates 5-3,5-4 and 5-5, includes federal and state coal leases, fee land and fee coal leases and the waste rock disposal site.

Disturbed Area Legal Description

Mine Site: Section 25: Portions of E1/2NW1/4SE1/4, E1/2SW1/4NE1/4, W1/2SW1/4NE1/ and area lying west of the west edge of Cottonwood Canyon Road

## 115 Status of Unsuitability Claims

To the best knowledge of Canyon Fuel Company, LLC, no portion of the area to be permitted is designated, or under study for being designated, unsuitable for mining.

Since the Mine Facilities area was in use before passage of the Surface Mining Control and Reclamation Act of 1977, the unsuitability criteria were not applied to the existing surface facilities.

Canyon Fuel Company, LLC does not propose to conduct coal mining or reclamation operations within 300 feet of any occupied dwelling. Coal mining and reclamation operations have been or will be conducted within 100 feet of a public road.

## 116 Permit Term

Mining at the Fossil Rock Mine is scheduled to begin rehabilitation of the old works in 2020/2021. Development mining will begin in 2022. Th applicant's plan is to begin longwall production in an adjacent lease in 2026. These dates will change depending on the coal market and the Applicant's resources. The mine plan for 2020 through 2023 with timing is presented on Plate 5-3.

The perimeter of the mine workings encompasses approximately 802.21acres which is the acres affected by the mine.

The disturbed area at the mine site is 10.39 acres (Plate 5-2). The disturbed area associated with the waste rock site is 15.82 acres (refer to Plate 4-1, Waste Rock volume of this M&RP).

## 117 Insurance and Proof of Publication

Certificates of Insurance issued to Canyon Fuel Company, LLC are located in the General Chapter 1 binder as prepared for the operations and on file with the Division.

The newspaper advertisement appears in Appendix 1-2. Verification of the advertisement appearing in the appropriate newspapers will be added to Appendix 1-2.

## 118 Filing Fee

The filing fee was submitted/paid to the Division in 1985.

## 120 Permit Application Format and Contents

The permit application contains clear, concise, current information, in the format required by the UDOGM.

## 130 Reporting of Technical Data

The technical data submitted in the permit application is accompanied by the names of persons or organizations that collected and analyzed the data. The technical data also contains the dates of collection and analysis of the data, and descriptions of the method used to collect and analyze data. A professional qualified in the subject, planed or directed the technical analyses.

## 140 Maps and Plans

The maps submitted in this permit application correspond to the format required by the regulations.

Those portions in the mine plan area in which underground coal mining activities occurred before August 3, 1997 and from August 3, 1977 to May 3, 1978 are presented on Plate 5-1.

## 150 Completeness

CFC believes the information in the permit application for its operations to be complete and correct.

# APPENDIX 1-1

# SPECIAL WARRANTY DEEDS, LEASES, RIGHT-OF-WAY DOCUMENTS

# (FORMERLY APPENDICES 4-1, 4-2 AND 4-4)

## APPENDIX 1-1

## Special Warranty Deeds, Leases, Right -of Entry Documents

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

Ent 412586 Page 1 of 3
Date: 16-Jun-2016 01:26PM
Fee: $14.00
Filed By: CJ
Connie Jensen, Recorder
EMERY COUNTY CORPORATION
For: FIRST AMERICAN TITLE INSURANCE

*RECORDING REQUESTED BY AND WHEN RECORDED RETURN TO:*

*Stoel Rives, LLP*
*Attn: Richard R. Hall*
*201 S. Main St., Suite 1100*
*Salt Lake City, Utah 84111*

(Space Above For Recorder's Use)

# SPECIAL WARRANTY DEED

**Tax Parcel No. L3-0011-0003**
**Trail Mountain Mine Sliver Parcel**

PACIFICORP, an Oregon corporation, having a mailing address of 1407 West North Temple, Suite 310, Salt Lake City, Utah 84116, as "***Grantor***", hereby conveys and warrants, against all those claiming by, through or under Grantor, but not otherwise, to FOSSIL ROCK RESOURCES, LLC, a Delaware limited liability company, having a mailing address of 6100 Dutchmans Lane, 9th Floor, Louisville, Kentucky 40205, as "***Grantee***," for the sum of TEN AND NO/100 DOLLARS ($10.00) and other good and valuable consideration, that certain parcel of real property located in Emery County, State of Utah, together with any and all interests, rights and appurtenances thereto, as well as any and all improvements thereon (if any), as more particularly described in Exhibit A attached hereto (described hereinafter as the "***Real Property***").

Subject to: (i) any state of facts that an accurate and complete ALTA/ACSM Land Title Survey might disclose, (ii) all zoning regulations, restrictions, rules and ordinances, land use regulations, building restrictions, and other laws and regulations now in effect or hereafter adopted by any governmental authority having jurisdiction, and (iii) reservations, easements, rights-of-way, declarations, covenants, conditions, restrictions, encroachments, liens, and encumbrances and all other matters of record or enforceable at law or in equity.

IN WITNESS WHEREOF, the said Grantor has executed this Special Warranty Deed as of this 24 day of May, 2016.

PACIFICORP,
an Oregon corporation

Cindy A. Crane
President/CEO - PacifiCorp dba Rocky Mountain Power

STATE OF UTAH )
:ss
COUNTY OF SALT LAKE )

The forgoing instrument was acknowledged before me this 24 day of May, 2016, by Cindy A. Crane, the President/CEO of the PacifiCorp dba Rocky Mountain Power, an Oregon corporation.

Witness my hand and official seal.

Notary Public
SALLY HILL
Commission #669027
My Commission Expires
September 17, 2016
State of Utah

Sally Hill
Notary Public

My Commission expires: 9-17-2016

Residing at: Salt Lake City, UT

86486802.1 0076000-02003

**Exhibit A**

Parcel East of Cottonwood Creek and West of Cottonwood Canyon Road

Legal Description:

That certain parcel of land located in Emery County, State of Utah, as more particularly described as follows:

Beginning at a point which is West, 116 Rods, more or less from the Northeast corner of the Southeast quarter of the Northeast quarter of Section 25, Township 17 South, Range 6 East, SLB&M (S 89°46'01" W, 1898.88 feet along 40 acre line by survey), said point being at the center of Cottonwood creek and running thence in a Southerly direction along center of said Creek to a point 84 Rods more or less, West of the Southeast corner of the Northeast quarter of the Southeast quarter of said Section 25 (S 89°20'20" W, 1482.82 feet along 40 acre line by survey); thence N 89°20'20" E, 68.64 feet to the centerline of Cottonwood Canyon Road; thence N 18°32'22" W, 211.65 feet along centerline of said road; thence N 18°00'23" W, 236.55 feet along centerline of said road; thence N 13°36'45" W, 219.23 feet along centerline of said road; thence N 10°17'37" W, 104.54 feet along centerline of said road; thence N 08°20'49" W, 350.40 feet along centerline of said road; thence N 10°33'11" W, 476.22 feet along centerline of said road; thence N 24°01'08" W, 163.55 feet along centerline of said road; thence N 20°01'04" W, 87.46 feet along centerline of said road; thence N 10°00'01" W, 150.85 feet along centerline of said road; thence N 02°27'38" W, 152.52 feet along centerline of said road; thence N 01°54'03" E, 211.25 feet along centerline of said road; thence N 00°12'51" W, 242.02 feet along centerline of said road; thence N 10°41'22" E, 106.12 feet along centerline of said road to the north line of the South half of the Northeast quarter of said Section 25; thence S 89°46'01" W, 48.79 feet along 40 acre line to the point of beginning.

Containing 2.86 acres more or less.

# APPENDIX 4-1

## Special Use Permit

| Forest Service, Department of Agriculture | a. Region (1-2) | b. Region (3-4) | c. Forest (5-6) |
|---|---|---|---|
| | 70 | 06 | 10 |
| SPECIAL USE PERMIT | d. District (7-8) | e. Unit number (9-12) | f. Kind of use (13-15) |
| | 02 | 4082 | 916 |
| Act of June 4, 1897<br>This permit is revocable and nontransferable<br>(Reg. FSM 2710) | g. State (16-17) | h. County (18-20) | i. Cost code (21) |
| | 49 | 015 | 1 |

Permission is hereby granted to MOTOMAS COAL COMPANY

of P.O. Box 370, Orangeville, Utah 84537

hereinafter called the permittee, to use subject to the conditions set out below, the following described lands or improvements:

SEE ATTACHED MAP

This permit covers .25 acres and/or 12 Ft. Wide 900 Ft. Length miles and is issued for the purpose of:

Installation of 4" steel pipeline for transportation of water to storage tank

1. Construction or occupancy and use under this permit shall begin within - - - months, and construction, if any, shall be completed within - - - months, from the date of the permit. This use shall be actually exercised at least 365 days each year, unless otherwise authorized in writing.

2. In consideration for this use, the permittee shall pay to the Forest Service, U.S. Department of Agriculture, the sum of Twenty five Dollars ($ 12.50 ) for the period from July 1 19 81, to December 31, 19 81, and thereafter annually on January 1 Twenty five Dollars ($ 25.00 ): *Provided, however,* Charges for this use may be made or readjusted whenever necessary to place the charges on a basis commensurate with the value of use authorized by this permit.

3. This permit is accepted subject to the conditions set forth herein, and to conditions 18 to 29 attached hereto and made a part of this permit.

| | NAME OF PERMITTEE | SIGNATURE OF AUTHORIZED OFFICER | DATE |
|---|---|---|---|
| PERMITTEE | MOTOMAS COAL COMPANY | TITLE | |
| | NAME AND SIGNATURE | TITLE | DATE |
| ISSUING OFFICER | | Acting Forest Supervisor | |

(CONTINUED ON REVERSE) 2700-4 (7/71)

4. Development plans, layout plans, reconstruction, remodeling, or alteration of improvements, or revision of layout or construction plans for this area must be approved in advance and in writing by the forest supervisor. Trees or shrubbery on the permitted area may be removed or destroyed only after the forest officer in charge has approved, and has marked or otherwise designated that which may be removed or destroyed. Timber cut or destroyed will be paid for by the permittee as follows: Merchantable timber at appraised value; young growth timber below merchantable size at current damage appraisal value; *provided* that the Forest Service reserves the right to dispose of the merchantable timber to others than the permittee at no stumpage cost to the permittee. Trees, shrubs, and other plants may be planted in such manner and in such places about the premises as may be approved by the forest officer in charge.

5. The permittee shall maintain the improvements and premises to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the forest officer in charge.

6. This permit is subject to all valid claims.

7. The permittee, in exercising the privileges granted by this permit, shall comply with the regulations of the Department of Agriculture and all Federal, State, county, and municipal laws, ordinances, or regulations which are applicable to the area or operations covered by this permit.

8. The permittee shall take all reasonable precautions to prevent and suppress forest fires. No material shall be disposed of by burning in open fires during the closed season established by law or regulation without a written permit from the forest officer in charge or his authorized agent.

9. The permittee shall exercise diligence in protecting from damage the land and property of the United States covered by and used in connection with this permit, and shall pay the United States for any damage resulting from negligence or from the violation of the terms of this permit or of any law or regulation applicable to the National Forests by the permittee, or by any agents or employees of the permittee acting within the scope of their agency or employment.

10. The permittee shall fully repair all damage, other than ordinary wear and tear, to national forest roads and trails caused by the permittee in the exercise of the privilege granted by this permit.

11. No Member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this agreement or to any benefit that may arise therefrom unless it is made with a corporation for its general benefit.

12. Upon abandonment, termination, revocation, or cancellation of this permit, the permittee shall remove within a reasonable time all structures and improvements except those owned by the United States, and shall restore the site, unless otherwise agreed upon in writing or in this permit. If the permittee fails to remove all such structures or improvements within a reasonable period, they shall become the property of the United States, but that will not relieve the permittee of liability for the cost of their removal and restoration of the site.

13. This permit is not transferable. If the permittee through voluntary sale or transfer, or through enforcement of contract, foreclosure, tax sale, or other valid legal proceeding shall cease to be the owner of the physical improvements other than those owned by the United States situated on the land described in this permit and is unable to furnish adequate proof of ability to redeem or otherwise reestablish title to said improvements, this permit shall be subject to cancellation. But if the person to whom title to said improvements shall have been transferred in either manner provided is qualified as a permittee and is willing that his future occupancy of the premises shall be subject to such new conditions and stipulations as existing or prospective circumstances may warrant, his continued occupancy of the premises may be authorized by permit to him if, in the opinion of the issuing officer or his successor, issuance of a permit is desirable and in the public interest.

14. In case of change of address, the permittee shall immediately notify the forest supervisor.

15. The temporary use and occupancy of the premises and improvements herein described may be sublet by the permittee to third parties only with the prior written approval of the forest supervisor but the permittee shall continue to be responsible for compliance with all conditions of this permit by persons to whom such premises may be sublet.

16. This permit may be terminated upon breach of any of the conditions herein or at the discretion of the regional forester or the Chief, Forest Service.

17. In the event of any conflict between any of the preceding printed clauses or any provisions thereof and any of the following clauses or any provisions thereof, the following clauses will control.

18. "A late payment charge in addition to the regular fees shall be made for failure to meet the fee payment due date or any of the dates specified for submission of statements required for fee calculation. The late payment charge shall be $15, or an amount calculated by applying the current rate prescribed by Treasury Fiscal Requirements Manual Bulletins to the overdue amount for each 30-day period or fraction thereof that the payment is overdue, whichever is greater. If the due date falls on a nonworkday, the late payment charge will not apply until the end of the next workday."

19. (B-2) - During the performance of this permit, the permittee agrees:

    a. In connection with the performance of work under this permit, including construction, maintenance, and operation of the facility, the permittee shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

    b. The permittee and his employees shall not discriminate by segregation or otherwise against any person on the basis of race, color, religion, sex, or national origin by curtailing or refusing to furnish accommodations, facilities, services, or use privileges offered to the public generally.

    c. The permittee shall include and require compliance with the above nondiscrimination provisions in any subcontract made with respect to the operations under this permit.

20. (B-8) - The permittee shall indemnify the United States against any liability for damage to life or property arising from the occupancy or use of National Forest lands under this permit.

21. (B-31) - Avalanches, rising waters, high winds, falling limbs or trees, and other hazards are natural phenomenons in the forest that present risks which the permittee assumes. The permittee has the responsibility of inspecting his site, lot, right-of-way, and immediate adjoining area for dangerous trees, hanging limbs, and other evidence of hazardous conditions and, after securing permission from the Forest Service, of removing such hazards.

22. (D-3) - The permittee shall protect the scenic esthetic values of the area under this permit, and the adjacent land, as far as possible with the authorized use, during construction, operation, and maintenance of the improvements.

23. (D-7) - The permittee shall be responsible for the prevention and control of soil erosion and gullying on the area covered by this permit and lands adjacent thereto, and shall provide preventive measures as required by the Forest Service.

24. (E-4) - Unless sooner terminated or revoked by the Regional Forester, in accordance with the provisions of the permit, this permit shall expire and become void on December 31, 1990, but a new permit to occupy and use the same National Forest land may be granted provided the permittee will comply with the then existing laws and regulations governing the occupancy and use of National Forest lands and shall have notified the Forest Supervisor not less than 6 months prior to said date that such new permit is desired.

25. (X-5) - The land herein described is subject to certain rights reserved by or outstanding in parties other than the United States, and nothing herein shall abridge said rights or authorize prevention or obstruction of the reasonable exercise thereof.

26. (X-19) - The permittee agrees to permit the free and unrestricted access to and upon the premises at all times for all lawful and proper purposes not inconsistent with the intent of the permit or with the reasonable exercise and enjoyment by the permittee of the privileges thereof.

27. (X-29) - No signs or advertising devices shall be erected on the area covered by this permit or highways leading thereto, without prior approval by the Forest Service as to location, design, size, color, and message. Erected signs shall be maintained or renewed as necessary to neat and presentable standards.

28. (X-33) - This permit is granted with the express understanding that should future location of Government improvements or road rights-of-way require the relocation of the permittee's improvements, such relocation will be done by the permittee at his expense within sixty (60) days following request to relocate.

29. (X-81) - This permit confers no right to the use of water by the permittee.

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
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| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
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| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 4-2

## Coal Leases

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

**COAL LEASE READJUSTMENT**

Serial Number U-082996

Lease Date July 1, 1962

**Part I. LEASE RIGHTS GRANTED**

This lease, entered into by and between the United States of America, hereinafter called the lessor, through the Bureau of Land Management, and

Mountain Coal Company
555 Seventeenth Street
Denver, CO 80202

hereinafter called lessee, is readjusted, effective July 1, 1992, for a period of 10 years and for so long thereafter as coal is produced in commercial quantities from the leased lands, subject to readjustment of lease terms at the end of each 10 year lease period.

**Sec. 1.** This lease readjustment is subject to the terms and provisions of the:

[X] Mineral Lands Leasing Act of 1920, Act of February 25, 1920, as amended, 41 Stat. 437, 30 U.S.C. 181-287, hereinafter referred to as the Act;

[ ] Mineral Leasing Act for Acquired Lands, Act of August 7, 1947, 61 Stat. 913, 30 U.S.C. 351-359;

and to the regulations and formal orders of the Secretary of the Interior which are now or hereafter in force, when not inconsistent with the express and specific provisions herein.

**Sec. 2.** Lessor, in consideration of any rents and royalties to be paid, and the conditions and covenants to be observed as herein set forth, hereby grants to lessee the exclusive right and privilege to drill for, mine, extract, remove or otherwise process and dispose of the coal deposits in, upon, or under the following described lands:

T. 17 S., R. 6 E., SLM, Utah
Sec. 25, E½E½SW¼, SW¼SE¼.

containing 80.00 acres, more or less, together with the right to construct such works, buildings, plants, structures, equipment and appliances and right to use such on-lease rights-of-way which may be necessary and convenient in the exercise of the rights and privileges granted, subject the conditions herein provided.

## PART II. TERMS AND C( )ITIONS

**Sec. 1. (a) RENTAL RATE.** Lessee shall pay lessor rental annually and in advance for each acre or fraction thereof during the continuance of the lease at the rate of $3.00 for each lease year.

**(b) RENTAL CREDITS.** Rental shall not be credited against either production or advance royalties for any year.

**Sec. 2. (a) PRODUCTION ROYALTIES.** The royalty shall be 12½ percent of the value of coal produced by strip or auger mining methods and 8 percent of the value of coal produced by underground mining methods. Royalties are due to lessor the final day of the months succeeding the calendar month in which the royalty obligation accrues.

**(b) ADVANCE ROYALTIES.** Upon request by the lessee, the authorized officer may accept for a total of not more than 10 years, the payment of advance royalties in lieu of continued operation, consistent with the regulations. The advance royalty shall be based on a percent of the value of a minimum number of tons determined in the manner established by the advance royalty regulations in effect at the time the lessee requests approval to pay advance royalties in lieu of continued operation.

**Sec. 3. BONDS.** Lessee shall maintain in the proper office a lease bond in the amount of $5,000. The authorized officer may require an adjustment in the amount of the bond to reflect changed conditions.

**Sec. 4. DILIGENCE.** This lease is subject to the conditions of diligent development and continued operation, except that these conditions are excused when operations under the lease are interrupted [illegible] strikes, the elements, or casualties not attributable to the lessee. The lessor, in the public interest, may suspend the condition of continued operation upon payment of advance royalties in accordance with the regulations in existence at the time of the suspension. Lessee's failure to produce coal in commercial quantities at the end of 10 years shall terminate the lease. If not submitted already, lessee shall submit an operation and reclamation plan pursuant to Section 7 of the Act not later than 3 years after the effective date of this lease readjustment.

The lessor reserves the power to assent to or order the suspension of the terms and conditions of this lease in accordance with, inter alia, Section 39 of the Mineral Leasing Act, 30 U.S.C. 209.

**Sec. 5. LOGICAL MINING UNIT (LMU).** Either upon approval by the lessor of the lessee's application or at the direction of the lessor, this lease shall become an LMU or part of an LMU, subject to the provisions set forth in the regulations.

The stipulations established in an LMU approval in effect at the time of LMU approval will supersede the relevant inconsistent terms of this lease so long as the lease remains committed to the LMU. If the LMU of which this lease is a part is dissolved, the lease shall then be subject to the lease terms which would have been applied if the lease had not been included in an LMU.

**Sec. 6. DOCUMENTS, EVIDENCE AND INSPECTION.** At such times and in such form as lessor may prescribe, lessee shall furnish detailed statements showing the amounts and quality of all products removed and sold from the lease, the proceeds therefrom, and the amount used for production purposes or unavoidably lost.

Lessee shall keep open a times for the inspection of any duly authorized officer of lessor, the leased premises and all surface and underground improvements, works, machinery, ore stockpiles, equipment, and all books, accounts, maps, and records relative to operations, surveys, or investigations on or under the leased lands.

Lessee shall allow lessor access to and copying of documents reasonably necessary to verify lessee compliance with terms and conditions of the lease.

While this lease remains in effect, information obtained under this section shall be closed to inspection by the public in accordance with the Freedom of Information Act (5 U.S.C. 552).

**Sec. 7. DAMAGES TO PROPERTY AND CONDUCT OF OPERATIONS.** Lessee shall comply at its own expense with all reasonable orders of the Secretary, respecting diligent operations, prevention of waste, and protection of other resources.

Lessee shall not conduct exploration operations, other than casual use, without an approved exploration plan. All exploration plans prior to the commencement of mining operations within an approved mining permit area shall be submitted to the authorized officer.

Lessee shall carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health, or property, and prevention of waste, damage or degradation to any land, air, water, cultural, biological, visual, and other resources, including mineral deposits and formations of mineral deposits not leased hereunder, and to other land uses or users. Lessee shall take measures deemed necessary by lessor to accomplish the intent of this lease term. Such measures may include, but : limited to, modification to proposed siting or design of facilities, timing of operations, and specification of interim and final reclamation procedures. Lessor reserves to itself the right to lease, sell, or otherwise dispose of the surface or other mineral deposits in the lands and the right to continue existing uses and to authorize future uses upon or in the leased lands, including issuing leases for mineral deposits, not covered hereunder and approving easements or rights-of-way. Lessor shall condition such uses to prevent unnecessary or unreasonable interference with rights of lessee as may be consistent with concepts of multiple use and multiple mineral development.

**Sec. 8. PROTECTION OF DIVERSE INTERESTS, AND EQUAL OPPORTUNITY.** Lessee shall: pay when due all taxes legally assessed and levied under the laws of the State or the United States; accord all employees complete freedom of purchase; pay all wages at least twice each month in lawful money of the United States; maintain a safe working environment in accordance with standard industry practices; restrict the workday to not more than 8 hours in any one day for underground workers, except in emergencies; and take measures necessary to protect the health and safety of the public. No person under the age of 16 years shall be employed in any mine below the surface. To the extent that laws of the State in which the lands are situated are more restrictive than the provisions in this paragraph, then the State laws apply.

Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor.

Neither lessee nor lessee's subcontractors shall maintain segregated facilities.

**Sec. 9(a) TRANSFERS**

/X/ This lease may be transferred in whole or in part to any person, association, or corporation qualified to hold such lease interest.

/ / This lease may be transferred in whole or in part to another public body, or to a person who will mine the coal on behalf of, and for the use of, the public body or to a person who for the limited purpose of creating a security interest in favor of a lender agrees to be obligated to mine the coal on behalf of the public body.

/ / This lease may only be transferred in whole or in pat to another small business qualified under 13 CFR 121.

Transfers of record title, working or royalty interest must be approved in accordance with the regulations.

**(b) RELINQUISHMENT.** The lessee may relinquish in writing at any time all rights under this lease or any portion thereof as provided in the regulations. Upon lessor's acceptance of the relinquishment, lessee shall be relieved of all future obligations under the lease or the relinquished portion thereof, whichever is applicable.

**Sec. 10. DELIVERY OF PREMISES, REMOVAL OF MACHINERY, EQUIPMENT, ETC.** At such time as all portions of this lease are returned to lessor, lessee shall deliver up to lessor the land leased, underground timbering, and such other supports and structures necessary for the preservation of the mine workings on the leased premises or deposits and place all workings in condition for suspension or abandonment. Within 180 days thereof, lessee shall remove from the premises all other structures, machinery, equipment, tools, and materials that it elects to or as required by the authorized officer. Any such structures, machinery, equipment, tools, and materials remaining on the leased lands beyond 180 days, or approved extension thereof, shall become the property of the lessor, but lessee shall either remove any or all such property or shall continue to be liable for the cost of removal and disposal in the amount actually incurred by the lessor. If the surface is owned by third parties, lessor shall waive the requirement for removal, provided the third parties do not object to such waiver. Lessee shall, prior to the termination of bond liability or at any other time when required and in accordance with all applicable laws and regulations, reclaim all lands the surface of which has been disturbed, dispose of all debris or solid waste, repair the offsite and onsite damage caused by lessee's activity or activities incidental thereto, and reclaim access roads or trails.

**Sec. 11. PROCEEDINGS IN CASE OF DEFAULT.** If lessee fails to comply with applicable laws, existing regulations, or the terms, conditions and stipulations of this lease, and the noncompliance continues for 30 days after written notice thereof, this lease shall be subject to cancellation by the lessor only by judicial proceedings. This provision shall not be construed to prevent the exercise by lessor of any other legal and equitable remedy, including waiver of the default. Any such remedy or waiver shall not prevent later cancellation for the same default occurring at any other time.

**Sec. 12. HEIRS AND SUCCESSORS - IN-INTEREST.** Each obligation of this lease shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

**Sec. 13. INDEMNIFICATION.** Lessee shall indemnify and hold harmless the United States from any and all claims arising out of the lessee's activities and operations under this lease.

**Sec. 14. SPECIAL STATUTES.** This lease is subject to the Federal Water Pollution Control Act (33 U.S.C. 1151 - 1175); the Clean Air Act (42 U.S.C. 1857 et seq.), and to all other applicable laws pertaining to exploration activities, mining operations and reclamation, including the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.)

**Sec. 15. SPECIAL STIPULATIONS.**

1. The Regulatory Authority shall mean the State Regulatory Authority pursuant to a cooperative agreement approved under 30 CFR Part 745 or in the absence of a cooperative agreement, Office of Surface Mining. The Authorized Officer shall mean the State Director, Bureau of Land Management. The Authorized Officer of the Surface Management Agency shall mean the Forest Supervisor, Forest Service. Surface Management Agency for private surface is the Bureau of Land Management. For adjoining private lands with Federal minerals and which primarily involve National Forest Service issues, the Forest Service will have the lead for environmental analysis and, when necessary, documentation in an environmental assessment or environmental impact statement.

2. The Authorized Officers of the Bureau of Land Management, Office of Surface Mining (Regulatory Authority), and the Surface Management Agency (Forest Service) respectively, shall coordinate, as practical, regulation of mining operations and associated activities on the lease area.

3. In accordance with Sec. 523(b) of the "Surface Mining Control and Reclamation Act of 1977," surface mining and reclamation operations conducted on this lease are to conform with the requirements of this Act and are subject to compliance with Office of Surface Mining Regulations, or as applicable, a Utah program equivalent approved under cooperative agreement in accordance with Sec. 523(c). The United States Government does not warrant that the entire tract will be susceptible to mining.

4. Federal Regulations 43 CFR 3400 pertaining to Coal Management make provisions for the Surface Management Agency, the surface of which is under the jurisdiction of any Federal agency other than the Department of Interior, to consent to leasing and to prescribe conditions to insure the use and protection of the lands. All or part of this lease contain lands the surface of which are managed by the United States Department of Agriculture, Forest Service Manti-LaSal National Forest.

The following stipulations pertain to the lessee responsibility for mining operations on the lease area and on adjacent areas as may be specifically designated on National Forest System lands.

5. Before undertaking activities that may disturb the surface of previously undisturbed leased lands, the lessee may be required to conduct a cultural resource inventory and a paleontological appraisal of the areas to be disturbed. These studies shall be conducted by qualified professional cultural resource specialists or qualified paleontologists, as appropriate, and a report prepared itemizing the findings. A plan will then be submitted making recommendations for the protection of, or measures to be taken to mitigate impacts for identified cultural or paleontological resources.

If cultural resources or paleontological remains (fossils) of significant scientific interest are discovered during operations under this lease, the lessee prior to disturbance shall, immediately bring them to the attention of the appropriate authorities. Paleontological remains of significant scientific interest do not include leaves, ferns, or dinosaur tracks commonly encountered during underground mining operations.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

6. If there is reason to believe that threatened or endangered (T&E) species of plants or animals, or migratory bird species of high Federal interest occur in the area the lessee shall be required to conduct an intensive field inventory of the area to be disturbed and/or impacted. The inventory shall be conducted by a qualified specialist and a report of findings will be prepared. A plan will be prepared making recommendations for the protection of these species or action necessary to mitigate the disturbance.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

7. The lessee shall be required to perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. Existing data may be used if such data is adequate for the intended purposes. The study shall be adequate to locate, quantify, and demonstrate the inter-relationship of the geology, topography, surface hydrology, vegetation, and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

8. Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to provide adequate protection for raptores and other large birds. When feasible, powerlines will be locate at least 100 yards from public roads.

9. Consideration will be given to site selection to reduce adverse visual impacts. Where alternative sites are available, and each alternative is technically feasible, the alternative involving the least damage to the scenery and other resources shall be selected. Permanent structures and facilities will be designed, and screening techniques employed, to reduce visual impacts, and where possible achieve a final landscape compatible with the natural surroundings. The creation of unusual, objectionable, or unnatural land forms and vegetative landscape features will be avoided.

10. The lessee shall be required to establish a monitoring system to locate, measure, and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and analytical method for location and measurement of a number of points over the lease area. The monitoring shall incorporate and be an extension of the baseline data.

11. The lessee shall provide for the suppression and control of fugitive dust on haul roads and at coal handling and storage facilities. On Forest Development Roads (FDR), lessees may perform their share of road maintenance by a commensurate share agreement if a significant degree of traffic is generated that is not related to their activities.

12. Except at specifically approved locations, underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would: (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to existing surface structures, and (3) damage or alter the flow of perennial streams. The lessee shall provide specific measures for the protection of escarpments, and determine corrective measures to assure that hazardous conditions are not created.

13. In order to avoid surface disturbance on steep canyon slopes and to preclude the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specifically approved locations.

14. The coal contained within, and authorized for mining under this lease, shall be extracted only by underground mining methods.

15. Existing Forest Service owned or permitted surface improvements will need to be protected, restored, or replaced to provide for the continuance of current land uses.

16. Support facilities, structures, equipment, and similar developments will be removed from the lease area within 2 years after the final termination of use of such facilities. This provision shall apply unless the requirement of Section 10 of the lease form is applicable. Disturbed areas and those areas previously occupied by such facilities will be stabilized and rehabilitated, drainages reestablished, and the areas returned to a premining land use.

17. The lessees at the conclusion of the mining operations, or at other times as surface disturbance related to mining may occur, will replace all damaged, disturbed, or displaced corner monuments (section corners, quarter corners, etc.) their accessories and appendages (witness trees, bearing trees, etc), or return them to their original condition and location, or at other locations that meet the requirements of the rectangular surveying system. This work shall be conducted at the expense of the lessee, by a professional land surveyor registered in the State of Utah and to the standards and guidelines found in the manual of surveying instruction, U.S. Department of Interior.

18. The lessee at his expense will be responsible to replace any surface water identified for protection, that may be lost or adversely affected by mining operations, with water from an alternate source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, livestock and wildlife use, or other land uses.

19. The lessee shall assure that mine facilities, parking areas, and equipment do not encroach on the Cottonwood Canyon Road nor interfere with traffic on this road.

20. Reasonable stock driveway access must be provided and maintained to the Trail Mountain cattle and horse allotment.

21. The Cottonwood Canyon road shall be maintained to insure suitable forest access as well as coal haulage. Because of the narrow confines of Cottonwood Canyon, all future and existing facilities such as power, telephone, water, and sewer lines, coal conveyers, and similar facilities, hall be constructed and/or maintained by the lessee to prevent interference with the Cottonwood Canyon road or access provided thereby.

22. The lessee must comply with all the rules and regulations of the Secretary of Agriculture set forth at Title 36, Chapter II, of the Code of Federal Regulations governing the use and management of the National Forest System (NFS) when not inconsistent with the rights granted by the Secretary of the Interior in the lease. The Secretary of Agriculture's rules and regulations must be complied with for (1)all use and occupancy of the NFS prior to approval of a permit/operation plan by the Secretary of Interior, (2) uses of all existing improvements, such as Forest Development Roads, within and outside the area licensed, permitted or leased by the Secretary of Interior, and (3) use and occupancy of the NFS not authorized by a permit/operation plan approved by the Secretary of the Interior.

All matters related to this stipulation are to be addressed to:

Forest Supervisor
Manti-LaSal National Forest
599 West Price River Drive
Price, Utah 84501

Telephone No.: 801-637-2817

ıo is the authorized representative of the Secretary of Agriculture.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SERIAL NUMBER U-082096
DATE OF LEASE July 1, 1962

COAL LEASE READJUSTMENT

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This lease between the United States of America (the lessor) through the Bureau of Land Management (BLM) and

Trail Mountain Coal Company
P. O. Box 356
Orangeville, Utah 84537

(lessee) is readjusted, effective as of July 1, 1983.

Sec. 1. STATUTES AND REGULATIONS. This lease readjustment is subject to the terms and provisions of the Mineral Leasing Act of February 25, 1920, as amended (41 Stat. 437, 30 U.S.C. §§ 181-263), hereinafter referred to as the Act, and of the Surface Mining Control and Reclamation Act of 1977. This lease is also subject to all regulations of the Secretary of the Interior (including, but not limited to, 30 CFR Part 211 and 43 CFR Group 3000) which are now or hereafter in force and which are made a part hereof. No amendment to the regulations made subsequent to the effective date hereof shall alter the rental and production royalty requirements in sections 5 and 6 of this lease until the next readjustment of this lease.

Sec. 2. RIGHTS OF LESSEE. The lessor, in consideration of the rents and royalty and other conditions hereinafter set forth, hereby grants to the lessee the exclusive right and privilege to mine and dispose of all coal in the following-described tracts (leased lands) situated in the State of Utah:

T. 17 S., R. 6 E., SLM, Utah
Sec. 25, E½E½SW¼, SW¼SE¼.

containing 80.00 acres, more or less, together with the right to construct all work, buildings, structures, equipment, and appliances which may be necessary and convenient for the mining and preparation of the coal for market, and subject to the conditions herein provided to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted for so long as this lease remains in full force and effect under any provisions of the law and the applicable regulations thereunder.

Sec. 3 DILIGENT DEVELOPMENT AND CONTINUED OPERATION. The lessee shall engage in the diligent development of the coal resources subject to the lease. After diligent development is achieved, the lessee shall maintain continued operation of the mine or mines on the leased lands. The terms diligent development and continued operation are defined in the applicable regulations in Titles 30 and 43 of the Code of Federal Regulations.

Sec. 4. BOND. The lessee shall file with the appropriate BLM office a lease bond in the amount of $5,000 for the use and benefit of the United States, to insure payment of rentals and royalties and to insure compliance with all other terms of this lease, the regulations and the Act. An increase in the amount of the bond may be required by the lessor at any time during the life of the lease to reflect changed conditions.

Sec. 5. RENTAL. An annual rental of $3.00 for each acre or fraction thereof shall be paid in advance on or before the anniversary date of this lease. Rentals under this lease shall be payable for each and every year during the continuance of the lease. Rentals paid for any lease year commencing prior to the effective date of this readjustment shall be credited against royalties for that year. Rentals due and payable for any lease year commencing on or after the effective date of this readjustment may not be credited against royalties (43 CFR 3473.3-1).

Sec. 6. PRODUCTION ROYALTY. The lessee shall pay a production royalty of 12½ percent of the value of coal produced by strip or auger mining methods and 8 percent of the value of coal produced by underground mining methods. The value of coal shall be determined as set forth in the regulations. Production royalties paid for a calendar month shall be reduced by the amount of any advance royalties paid under this lease to the extent that such advance royalties have not been used to reduce production royalties in a previous month. Production royalties shall be payable the final day of the month succeeding the calendar month in which coal is mined.

Sec. 7. ADVANCE ROYALTY. Upon request by the lessee the Mining Supervisor may accept, for a total of not more than ten years, the payment of advance royalties in lieu of the condition of continued operation for any particular year. Any payment of advance royalties in lieu of continued operation shall be pursuant to an agreement, signed by the lessee and the Mining Supervisor, which shall be made a part of this lease. The agreement shall include a schedule of payments and shall be subject to the advance royalty conditions set forth in the regulations. The advance royalty shall be based on a percent of the value of a minimum number of tons which shall be determined on a schedule sufficient to exhaust the leased reserves in 40 years from the date of approval of the mining and reclamation plans or from June 1, 1976, depending on effective date of the lease.

Sec. 8. METHOD OF PAYMENTS. The lessee shall make rental payments to the appropriate BLM office until either production royalties or advance royalties become payable. Thereafter, all rentals, production royalties and advance royalties shall be paid to the Mining Supervisor. All remittances to BLM shall be made payable to the Bureau of Land Management; those to the Minerals Management Service shall be made payable to the Minerals Management Service.

Sec. 9. EXPLORATION PLAN. As specified in the regulations, the lessee shall submit an exploration plan before conducting any exploration on the leased lands, except casual use, between the effective date of this lease and the date of approval of the mining plan. The lessee shall not commence exploration without an approved exploration plan. Thereafter, the lessee shall conduct all exploration in accordance with the approved exploration plan.

Sec. 10. MINING PLAN. In accordance with the regulations in 30 CFR 211, 700, and 800, if the Lessee has not yet submitted a mining plan, he must do so within three years after the effective date of this readjustment. Unless or until the mining plan has been approved, the Lessee shall not conduct any operations on the leased lands except casual use or exploration, if an exploration plan has been approved. Thereafter, the Lessee shall conduct all operations in accordance with the approved mining plan.

Sec. 11. LOGICAL MINING UNITS (LMU). This lease is automatically considered to be an LMU and may be combined with other land, including other Federal leaseholds and non-Federal interests in coal, to form a larger LMU. The mining plan for such enlarged LMU must include a production schedule that provides for the mining of all the LMU reserves, both Federal and non-Federal, in a period of not more than 40 years from the date of the approval of the plan. The definition of LMU and LMU reserves and other conditions applicable to them are set forth in the regulations (43 CFR 3400.0-5).

Sec. 12. OPERATIONS ON LEASED LANDS. In accordance with the conditions of this lease, the exploration and mining plans, the regulations and the Act, the lessee shall exercise reasonable diligence, skill and care in all operations on the leased lands. The lessee's obligations shall include, but not be limited to the following:

(a) The lessee shall conduct all operations on the leased lands so as to avoid injury to life, health, or property.

(b) The lessee shall conduct operations in such a manner as may be needed to avoid or, where avoidance is impracticable, to minimize and where practicable, to repair damage to: (1) any forage and timber growth on Federal lands; (2) crops, including forage and timber, or improvements of a surface owner; or (3) improvements, whether owned by the United States or by its permittees, licensees, or lessees. The lessor must approve the steps to be taken and the restoration to be made in the event of the occurrence of damage described in this subsection.

(c) The lessee shall minimize to the maximum extent possible wasting of the mineral deposits and other resources, including, but not limited to, surface resources which may be found in, upon, or under such lands.

Sec. 13. AUTHORIZATION OF OTHER USES AND DISPOSITION OF LEASED LANDS.

(a) The lessor reserves the right to authorize other uses of the leased lands by regulation or by issuing, in addition to this lease, leases, licenses, permits, easements or rights-of-way, including leases for the development of minerals other than coal under the Act. The lessor may authorize any other uses of the leased lands that do not unreasonably interfere with the exploration and mining operations of the lessee, and the lessee shall make all reasonable efforts to avoid interference with such authorized uses.

(b) The lessor reserves the right (1) to sell or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the coal therein, or (2) to dispose of any resource in such lands if such disposal will not unreasonably interfere with the exploration and mining operations of the lessee.

(c) If the leased lands have been or shall hereafter be disposed of under laws reserving to the United State the deposits of coal therein, the lessee shall comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such coal.

Sec. 14. EQUAL OPPORTUNITY CLAUSE. The lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations and relevant orders of the Secretary of Labor.

Sec. 15. CERTIFICATION OF NONSEGREGATED FACILITIES. By entering into this lease, the lessee certifies that he does not and will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not and will not permit his employees to perform their services at any location under his control where segregated facilities are maintained. The lessee agrees that a breach of this certification is a violation of the Equal Opportunity clause of this lease. As used in this certification, the term "segregated facilities" means, but is not limited to, any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. Lessee further agrees that (except where the lessee has obtained identical certifications from proposed contractors and subcontractors for specific time periods) lessee will obtain identical certifications from proposed contractors and subcontractors prior to award of contracts or subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity Clause; that lessee will retain such certifications in lessee's files; and that lessee will

forward the following notice to such proposed contractors and subcontractors (except where proposed contractor or subcontractor has submitted identical certifications for specific time periods). Notice is to be provided by lessee to prospective contractors and subcontractors of requirement for certification of nonsegregated facilities. A Certification of Nonsegregated Facilities, as required by the May 9, 1967 Order (32 F. R. 7439, May 19, 1967) on Elimination of Segregated Facilities, by the Secretary of Labor, must be submitted prior to the award of a contract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity Clause. Certification may be submitted either for each contract and subcontract or for all contracts and subcontracts during a period (i.e., quarterly, semiannually, or annually).

Sec. 16. EMPLOYMENT PRACTICES. The lessee shall pay all wages due persons employed on the leased lands at least twice each month in lawful money of the United States. The lessee shall grant all miners and other employees complete freedom to purchase goods and services of their own choice. The lessee shall restrict the workday to not more than 8 hours in any one day for underground workers, except in case of emergency. The lessee shall employ no person under the age of 16 years in any mine below the surface. If the laws of the State in which the mine is situated provides for a minimum age restriction for mining below the surface, other than the requirements of Federal Law, the laws of the State shall prevail.

Sec. 17. MONOPOLY AND FAIR PRACTICES. The lessor reserves full authority to promulgate and enforce orders and regulations under the provisions of Sections 30 and 32 of the Act (30 U.S.C. §§ 187 and 189) necessary to insure that any sale of the production from the leased lands to the United States or to the public is at reasonable prices, to prevent monopoly, and to safeguard the public welfare, and such regulations shall upon promulgation be binding upon the lessee.

Sec. 18. ASSIGNMENT. This lease may be assigned, upon approval of the authorized officer in accordance with the provisions of 43 CFR Subpart 3453. An assignment will become effective on the first day of the month following approval by the authorized officer or, if the assignee requests, the first day of the month of approval.

Sec. 19. RELINQUISHMENT OF LEASE. The lessee may file a request to relinquish all or any legal subdivision of this lease. The request shall be filed in duplicate with the authorized officer. The authorized officer shall approve the relinquishment if he determines that the lessee has complied with the requirements of the lease, the exploration and mining plans, the regulations and the Act. Upon approval, the relinquishment shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety to pay all accrued rentals and royalties and to comply with all other requirements of the lease, the regulations and the Act.

Sec. 20. NONCOMPLIANCE. Any failure to comply with the conditions of this lease, the exploration and mining plans, the regulations, or the Act shall be dealt with in accordance with the procedures set forth in the regulations.

Sec. 21. WAIVER OF CONDITIONS. The lessor reserves the right to waive any breach of the conditions contained in this lease, except the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular breach prevent cancellation of this lease for any other cause or for the same cause occurring at another time.

Sec. 22. READJUSTMENT OF TERMS AND CONDITIONS. (a) This lease is subject to reasonable readjustment of any conditions of the lease, including royalty rates, at the end of this readjustment period on July 1, 1992, and subject to readjustment at the end of each 10 year period thereafter. The lessor shall notify the lessee whether he intends to readjust conditions and, if he intends to readjust, the nature of the readjustments. The lessor shall give notice 120 days before the end of this readjustment period as to whether the lease terms will be readjusted. Unless the lessee, within 60 days after receipt of the proposed readjusted conditions files with the lessor an objection or relinquishes the lease as of the effective date of the readjustment, the lessee shall be deemed conclusively to have agreed to such conditions.

(b) If the lessee files objections to the proposed readjusted conditions with the lessor, and agreement cannot be reached between the lessor and the lessee within a period of 60 days after the filing of the objections, the lease may be terminated by either party upon giving 30 days' notice to the other party; however, the lessor's right to terminate the lease shall be suspended by the lessee's filing of a notice of appeal pursuant to section 29 of this lease, and if the lessee is ultimately successful in his appeal, the lease shall continue without the change in the provisions, the imposition of which, the lessee appealed. If the lessee is unsuccessful in his appeal and within 30 days after receipt of the decision on appeal notifies the lessor that he accepts the decision rendered upon such appeal, then the lease shall continue as amended by the decision.

(c) If the lessee files objections to the proposed readjusted conditions, the existing conditions, except those concerning royalties, shall remain in effect until there has been an agreement between the lessor and the lessee on the new conditions to be incorporated in the lease, or until the lease is terminated; however; the readjusted royalty provisions shall be effective until there is either agreement between the lessor and the lessee or until the lease is terminated. If the readjusted royalty provisions are subsequently rescinded or amended; the lessee shall be permitted to credit any excess royalty payments against royalties subsequently due to the lessor.

Sec. 23. DELIVERY OF PREMISES. Upon termination of this lease for any reason, or relinquishment of a part of this lease, the lessee shall deliver to the lessor in good order and condition all or the appropriate part of the leased lands. Delivery of the leased lands shall include underground timbering and such other supports and structures as are necessary for the preservation of the mine or deposit, and shall be in accordance with all other applicable provisions of the regulations for the completion of operations and abandonment.

Sec. 24. PROPRIETARY INFORMATION. Geological and geophysical data and information, including maps, trade secrets, and commercial and financial information which the lessor obtains from the lessee shall be treated in accordance with 43 CFR Part 2 and other applicable regulations.

Sec. 25. LESSEE'S LIABILITY TO LESSOR.

(a) The lessee shall be liable to the United States for any damage suffered by the United States in any way arising from or connected with the lessee's activities and operations under this lease, except where damage is caused by employees of the United States acting within the scope of their authority.

(b) The lessee shall indemnify and hold harmless the United States from any and all claims arising from or connected with the lessee's activities and operations under this lease.

(c) In any case where liability without fault is imposed on the lessee pursuant to this section, and the damages involved were caused by the action of a third party, the rules of subrogation shall apply in accordance with the law of the jurisdiction where the damages occurred.

Sec. 26. INSPECTIONS AND INVESTIGATIONS.

(a) All books and records maintained by the lessee showing information required by this lease or regulations must be kept current and in such manner that the books and records can be readily checked, upon request, by the Mining Supervisor or his representative at the place where they are customarily maintained.

(b) The lessee shall permit any duly authorized officer or representative of the lessor at any reasonable time (1) to inspect or investigate the leased lands and all surface and underground improvements, works, machinery, and equipment, and all books and records pertaining to the lessee's obligations to the lessor under this lease and regulations and (2) copy, and make extracts from any such books and records.

Sec. 27. UNLAWFUL INTEREST. No member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, either before or after he has qualified and during his continuance in office, and no officer, or employee of the Department of the Interior, except as provided in 43 CFR 7.4 (a)(3), shall hold any share or part in this lease or derive any benefit therefrom. The provisions of Section 3741 of the Revised Statutes, as amended, 41 U.S.C. Section 22, and the Act of June 25, 1948, (62 Stat. 702, as amended, 18 U.S.C. §§ 431-433), relating to contracts, enter into and form a part of this lease insofar as they may be applicable.

Sec. 28. APPEALS. The lessee shall have the right to appeal (a) under 43 CFR 3000.4 from an action or decision of any official of the Bureau of Land Management (b) under 30 CFR Part 290 from an action, order, or decision of any official of the Minerals Management Service, or (c) under applicable regulations from any action or decision of any other official of the Department of the Interior arising in connection with this lease, including any action or decision pursuant to Section 23 of this lease with respect to the readjustment of conditions.

Sec. 29. SPECIAL STATUTES. This lease is also subject to the provisions of the Federal Water Pollution Control Act (33 U.S.C. 1151-1175) and the Clean Air Act (42 U.S.C. 1857).

Sec. 30. SPECIAL STIPULATIONS.

The District Mining Supervisor shall mean the authorized representative of the Minerals Management Service and the Regional Director shall mean the authorized representative of the Office of Surface Mining. The Authorized Officer shall mean the State Director, Bureau of Land Management. The Authorized Officer of the Surface Management Agency shall mean the Forest Supervisor, Forest Service. The surface management agency for private surface shall be the Forest Service.

1. The Lessee will be responsible to comply with applicable Federal, State, and local laws and regulations.

2. In accordance with Sec. 523(b) of the "Surface Mining Control and Reclamation Act of 1977," surface mining and reclamation operations conducted on this lease are to conform with the requirements of this Act and are subject to compliance with Office of Surface Mining Regulations, or as applicable, a Utah program equivalent approved under cooperative agreement in accordance with Sec. 523(c) and final determination of suitability for mining. The United States Government does not warrant that the entire tract will be susceptible to mining.

3. The coal contained within the lease area and authorized for mining under this lease shall be extracted only by underground mining methods.

4. All support facilities, structures, equipment, and similar developments will be removed from the lease area within two years after the final termination of use of such facilities. All disturbed areas and those areas occupied by such facilities will be rehabilitated in accordance with an approved reclamation plan, 30 CFR 211 and the "Surface Mining Control and Reclamation Act of 1977" or approved Utah program as applicable.

5. (a) Before undertaking any activities that may disturb the surface of the lease lands, the Lessee may be required to conduct a cultural resource intensive field inventory in a manner specified by the Regional Director and the Authorized Officer of the surface managing agency on portions of the mine plan area and adjacent areas, or exploration plan area, that may be adversely affected by lease-related activities and which were not previously inventoried at such a level of intensity. The inventory shall be conducted by a qualified professional cultural resource specialist (i.e., archaeologist, historian, or historical architect, as appropriate), approved by the Authorized Officer of the surface managing agency

and a report of the inventory and recommendations for protecting any cultural resources identified shall be submitted to the Regional Director (or the District Mining Supervisor if activities are associated with coal exploration outside an approved mining permit area) and the Authorized Officer of the surface managing agency. The Lessee shall undertake measures, in accordance with instructions from the Regional Director (or the District Mining Supervisor if activities are associated with coal exploration outside an approved mining permit area). to protect cultural resources on the leased land. The Lessee shall not commence the surface disturbing activities until permission to proceed is given by the Regional Director or the District Mining Supervisor as appropriate.

(b) The Lessee shall protect all cultural resource properties within the lease area from lease-related activities until the cultural resource mitigation measures can be implemented as part of an approved mining and reclamation plan or exploration plan.

(c) The cost of conducting the inventory, preparing reports, and carrying out mitigation measures shall be borne by the Lessee.

(d) If cultural resources are discovered during operations under this lease, the Lessee shall immediately bring them to the attention of the Regional Director, (or the District Mining Supervisor as appropriate), and the Authorized Officer, Surface Management Agency. The Lessee shall not disturb such resources except as may be subsequently authorized by the Regional Director (or the District Mining Supervisor). Within two (2) working days of notification, the Regional Director (or the District Mining Supervisor, as appropriate) will evaluate or have evaluated any cultural resources discovered and will determine if any action may be required to protect or preserve such discoveries.

(e) All cultural resources shall remain under the jurisdiction of the United States until ownership is determined under applicable law.

6. Before undertaking any activities that may disturb the surface of the leased lands, the Lessee shall contact the Regional Director and Authorized Officer of the Surface Management Agency to determine whether the Lessee will be required to conduct a paleontological appraisal of the mine plan and adjacent areas, or exploration plan areas, that may be adversely affected by lease-related activities. If the Regional Director and Authorized Officer, Surface Management Agency, determines that one is necessary, the paleontological appraisal shall be conducted by a qualified paleontologist approved by the Authorized Officer of the surface management agency, using the published literature and, where appropriate, field appraisals for determining the possible existence of fossils of scientific significance. A report of the appraisal and recommendations for protecting any fossils of significant scientific interest on the leased lands so identified shall be submitted to and approved by the Regional Director and the Authorized Officer, Surface Management Agency. When necessary to protect and/or collect the fossils of significant scientific interest on the leased lands, the Lessee shall undertake the measures provided in the approval of the mining and reclamation plan or exploration plan.

(a) The Lessee shall not knowingly disturb, alter, destroy, or take any fossils of significant scientific interest, and shall protect all such fossils in conformance with the measures included in the approval of the mining and reclamation plan or exploration plan.

(b) The Lessee shall immediately bring any such fossils that might be altered or destroyed by his operation to the attention of the Regional Director or the District Mining Supervisor, as appropriate. Operations may continue as long as the fossil specimen or specimens would not be seriously damaged or destroyed by the activity. The Regional Director or the District Mining Supervisor, as appropriate, shall evaluate or have evaluated such discoveries brought to his attention and, within five (5) working days, shall notify the Lessee what action shall be taken with respect to such discoveries.

(c) All such fossils of significant scientific interest shall remain under the jurisdiction of the United States until ownership is determined under applicable law. Copies of all paleontological resource data generated as a result of the lease term requirements will be provided to the Regional Director or the District Mining Supervisor, as appropriate.

(d) These conditions apply to all such fossils of significant scientific interest discovered within the lease area whether discovered in the overburden, interburden, or coal seam or seams. Fossils of significant scientific interest do not include those fossils commonly encountered during underground mining operations such as ferns and dinosaur tracks. Skeletal remains shall be considered significant.

7. The Lessee shall, prior to entry upon the lease, conduct an intensive field inventory for threatened and endangered plant and/or animal species, bald or golden eagles, or migratory species of high Federal interest on those areas to be disturbed and/or impacted including the access routes to the lease area. The inventory shall be conducted by a qualified specialist(s) approved by the Authorized Officer, Surface Management Agency, and a report of the inventory and recommendation for the protection of these species submitted to and approved by the Authorized Officer, Surface Management Agency, and Regional Director or District Mining Supervisor as appropriate. An acceptable report of any findings shall include the specific location, distribution, and habitat requirements of the species. The Lessee shall protect these species within the lease area from any activities associated with operations conducted under the terms of the lease and shall undertake such protective measures as may be required by the Authorized Officer, Surface Management Agency, and Regional Director, or District Mining Supervisor, as appropriate.

8. Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to conform with the publication, "Suggested Practices for Raptor Protection on Powerlines" (Edison Electric Institute, 1975). When feasible, powerlines will be located at least 100 yards from public roads.

9. The Lessee shall provide for the suppression and control of fugitive dust on all haul roads, and at coal hauling, transportation, and storage facilities. The migration of road surfacing materials shall be controlled by watering, chemical treatment, or hard surfacing. Loss of gravel courses shall be periodically replaced.

10. In order to avoid surface disturbance on steep canyon slopes and the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specific locations approved by the Regional Director with the concurrence of the Authorized Officer, Surface Management Agency and the District Mining Supervisor.

11. Prior to mining, the Lessee shall perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. The study will be established in consultation with and approved by the Authorized Officer, Surface Management Agency, the Regional Director, and the District Mining Supervisor and shall be adequate to locate, quantify, and demonstrate the interrelationship of the geology, topography, surface hydrology, vegetation, and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

12. The Lessee shall establish a monitoring system to locate, measure, and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology, and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a sufficient number of points over the lease area. The monitoring shall be an extension of the baseline data and shall be conducted by a method approved by the Regional Director in consultation with and concurrence by the Authorized Officer, Surface Management Agency and District Mining Supervisor.

13. Underground mining operations shall be conducted in such a manner so as to prevent surface subsistence that would (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides. (2) cause damage to surface structures, and improvements, and (3) damage or alter the flow of perennial streams. The Lessee in his mining plan shall provide specific measures for the protection of escarpments. The Regional Director in consultation with and concurrence of the District Mining Supervisor and Authorized Officer, Surface Management Agency, shall approve such measures and may prescribe any additional measures to be employed such as mining methods, specify the amount of coal recovered, and determine any corrective measures considered necessary to assure that escarpment failure does not occur except at specifically approved locations, or that hazardous conditions are not created.

14. Existing surface improvements required for the surface uses of the lease area will need to be protected or maintained to provide for the post-mining continuance of the current land uses. Existing surface improvements whose utility may be lost or damaged as result of mining activities are to be replaced or restored.

15. The Lessee shall reclaim all areas disturbed as a result of mining and exploration operations to a land use capable of supporting the pre-mining levels of livestock grazing, big game winter range, and other wildlife habitat.

16. At the conclusion of the mining operation, or at the request of the Authorized Officer of the Surface Managing Agency, all damaged, disturbed, or displaced land monuments, accessories and appendages shall be replaced or restored in their original location (or at other locations that meet the needs of the land net, and as approved by the Authorized Officer of the Surface Managing Agency) and shall be done at the expense of the Lessee.

17. The Lessee will be responsible to replace any water lost or adversely affected by mining operations with water from an alternative source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, and livestock and wildlife use.

18. The Lessee will be required to reconstruct the road in Cottonwood Canyon from the mine site to Highway 29 in a manner agreeable to Emery County and the authorized officer of the Surface Management agencies. In the interim, until reconstruction is completed, traffic management requirements will be imposed on the existing road commensurate with the season of use, road conditions, and volumes of traffic.

19. The Lessee shall assure that mine facilities, parking areas, and equipment do not encroach on the Cottonwood Canyon Road nor interfere with traffic on this road.

20. Reasonable stock driveway access must be provided and maintained to the Trail Mountain cattle and horse allotment.

21. The Cottonwood Canyon Road shall be maintained in such a manner so as to provide suitable forest access as well as coal haulage. Because of the narrow confines of Cottonwood Canyon, all future and existing facilities such as power, telephone, water and sewer lines, coal conveyors, and similar facilities, shall be constructed and/or maintained by the Lessee so as to not interfere with the Cottonwood Canyon Road or access provided thereby.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Serial Number

Utah 032936

MODIFIED COAL LEASE

This lease is entered into on , by the United States of America, the lessor, through the Bureau of Land Management, and

John Bell
P.O. Box 356
Orangeville, UT 84537

and shall become effective on July 1, 1982, the effective date of the original lease. , the lessee,

Sec. 1. STATUTES AND REGULATIONS – This lease is issued pursuant and subject to the terms and provisions of the Mineral Leasing Act of February 25, 1920, 41 Stat. 437, as amended, 30 U.S.C. Sections 181–263, hereafter referred to as the Act. This lease is also subject to all regulations of the Secretary of the Interior (including, but not limited to, 30 CFR Part 211 and 43 CFR Group 3000) which are now or hereafter in force and which are made a part hereof, except that no amendment to the regulations made subsequent to the effective date of this lease shall alter the rental and production royalty requirements in Section 5 and 6 of this lease. (continued on page 3)

WITNESSETH:

Sec. 2. RIGHTS OF LESSEE - (a) The lessee is now the holder of coal lease Utah 032936, issued July 1, 1982, under the above-cited Act, which embraces 40 acres in Emery County, Utah.

(b) Upon application by the lessee for modification of the lease, it has been found that it would be in the interest of the United States to modify the lease under Sec. 3 of the Act cited to include as additional lands the following: Sec. 25, T. 17 S., R. 6 E., SLM, Utah, containing 40 acres.

(c) The lessor, in consideration of the bonus, rents, and royalties and other conditions hereinafter set forth hereby grants and leases to the lessee the exclusive right and privilege to mine and dispose of all coal in the following-described tracts (leased lands) situated in the State of Utah:

Tract #1: T. 17 S., R. 6 E., SLM, Utah
Sec. 25, SW¼SE¼.

Containing 40 acres.

Request for Approval of Assignment

Trail Mountain Coal Company hereby requests approval of Assignment of certain coal lands in the State of Utah:

Tract No. 1: T.17S., R.6E. SLM
Sec. 25, SW¼ SE¼
Containing 40 Acres

Tract No. 2: T.17S., R.6E. SLM
Sec. 25, E½ E½ SW¼
Containing 40 Acres

Trail Mountain Coal Company is a corporation authorized to do business in Utah. A statement of qualifications is on file under U-38700. Assignee's interests do not exceed allowable levels in Utah since Trail Mountain Coal Company holds no federal leases at this time. The Assignee is the sole party in interest in this Assignment. The $50.00 filing fee is attached.

President

AMENDED

ASSIGNMENT OF FEDERAL COAL LEASE

FOR GOOD AND VALUABLE CONSIDERATION, RECEIPT OF WHICH IS HEREBY ACKNOWLEDGED AND SUBJECT TO THE APPROVAL OF THE UNITED STATES BUREAU OF LAND MANAGEMENT, I, JOHN L. BELL OF 123 2nd AVE., SALT LAKE CITY, UTAH, 84103 THE SESSEE OF THAT CERTAIN FEDERAL COAL LEASE, SERIAL NO U-08[illegible]96, SITUATED IN THE STATE OF UTAH.

RECEIVED
STATE OFFICE
1980 AUG -4 PM 4: 19
DEPT OF INTERIOR
BUR. OF LAND MGMT.

TRACT #1 T.17 S.,R.6 E.SLM, UTAH
SEC. 25, SW¼ SE¼
CONTAINING 40 ACRES

TRACT #2 T.17 S., R.6 E.SLM, UTAH
SEC. 25, E½ E½ SW¼
CONTAINING 40 ACRES

DO HEREBY ASSIGN, TRANSFER AND CONVEY SAID LEASE UNTO TRAIL MOUNTAIN COAL COMPANY, A UTAH CORPORATION WITH ITS MINE OFFICE AT P.O.BOX 356, ORANGEVILLE, UTAH 84537 AND THE PRINCIPAL OFFICE AT P.O. BOX 84, SOMERSET, PENNSYLVANIA, 15501.

TO HAVE AND HOLD THE SAME FOR THE REMAINDER OF THE TERM OF SAID LEASE AND SUBJECT TO THE BONUS, RENTS, ROYALTIES, AND PROVISIONS THERE IN SPECIFIED.

WITNESS THIS 4TH DAY OF AUGUST, 1980 John L Bell

STATE OF UTAH )
: SS.
COUNTY OF SALT LAKE )

PERSONALLY APPEARED BEFORE ME THIS 4th DAY OF AUGUST, 1980, JOHN L. BELL, THE SIGNER OF THE FOREGOING INSTRUMENT WHO DULY ACKNOWLEDGED TO ME THAT HE EXECUTED THE SAME.

Notary Public
NOTARY PUBLIC

MY COMMISSION EXPIRES:
9-9-82.

RESIDENCE: SLC, UT

# SHARE PURCHASE AGREEMENT

THIS AGREEMENT is made and entered the 8th day of January, 1981, by and among the holders (the "Shareholders") of all the outstanding shares of common stock, without par value (the "Shares"), of TRAIL MOUNTAIN COAL COMPANY, a Utah corporation (the "Company"), and NATOMAS MINERALS OF UTAH, INC. and NATOMAS TRAIL MOUNTAIN COAL COMPANY, California corporations (the "Purchasers"), and provides for the purchase of the Shares by the Purchasers from the Shareholders.

In consideration of the mutual covenants, agreements, representations, warranties and other provisions contained herein, the parties agree as follows:

## SECTION 1. PURCHASE AND SALE OF THE SHARES

### A. Agreement to Purchase and Sell

Subject to the terms and conditions of this Agreement, on the Closing Date (as hereinafter defined) the Purchasers (in the respective portions indicated in Section 7 hereof) will purchase from the Shareholders, and the Shareholders will sell, transfer and convey to the Purchasers, the Shares, for an aggregate purchase price (the "Purchase Price") of [illegible] (including payment or assumption of the liabilities of the Company). In a simultaneous transaction, a designee of the Purchasers will acquire from the Estate of Myron F. Fetterolf (the "Estate") an assignment of the Estate's rights as lessee under the coal lease with the State of Utah as lessor known as the "McKinnon Lease" (more particularly described on Exhibit D hereto) for a consideration of [illegible]

### B. Advance Payment

The Purchasers, upon the execution and delivery of this Agreement, have paid to The Fetterolf Group, Inc. as agent for the Shareholders the sum of [illegible] (the "Advance Payment"), as a payment in advance of a portion of the Purchase Price. The Advance Payment is secured by a statement authorizing confession of judgment of The Fetterolf Group, Inc., and shall be credited against the Purchase Price on the Closing Date (and any interest earned thereon shall be retained by The Fetterolf Group, Inc. on behalf of the Shareholders). In the event of termination of this Agreement pursuant to clause (a), (b), (d), (f), (g) or (h) of Section 20 hereof, the entire amount of the Advance Payment shall be returned to the Purchasers, with interest thereon at the prime rate of the Pittsburgh National Bank; provided, however, that if this Agreement is terminated pursuant to clause (b) of Section 20 hereof, one-half of the accrued interest shall be forgiven by the Purchasers. In the event of termination of this Agreement pursuant to clause (c) or (e) of Section 20 hereof, the Advance Payment (and any interest earned thereon) may be retained by The Fetterolf Group, Inc. on behalf of the Shareholders.

### C. Escrow Deposit

The Purchasers, promptly after the execution and delivery of this Agreement, shall also deposit into the Escrow Account referred to in Section 8 hereof the sum of [illegible] (the "Escrow Deposit") as an additional payment in advance of a portion of the Purchase Price, to be held and disposed of in accordance with Section 8 and the Escrow Agreement referred to therein.

(iv) extraordinary loss (as defined in Opinion No. 30 of the Accounting Principles Board of the American Institute of Certified Public Accountants and in Financial Accounting Standards Board Statement No. 16) suffered by the Company which singly or in the aggregate is material to the Company, or any waiver by the Company of any rights of substantial value which singly or in the aggregate are material to the financial condition or the operations of the business of the Company;

(v) capital commitment or expenditure by the Company exceeding $10,000 not listed on Exhibit B to this Agreement;

(vi) issuance or commitment to issue capital stock of the Company, or declaration, setting aside or payment of a dividend or other distribution in respect of the capital stock of the Company, or any direct or indirect redemption, purchase or other acquisition by the Company of any of its capital stock; or

(vii) any other event, condition or state of facts of any character which materially and adversely affects, or threatens materially and adversely to affect, the results of operations or business or financial condition or prospects of the Company.

The Company has not since November 30, 1980, engaged in any transaction material to the Company not in the ordinary course of business. As used in this Section and elsewhere in this Agreement, "ordinary course of business" refers to ordinary day-to-day business activity conducted in a commercially reasonable and businesslike manner, having no unusual or special features, and being such as a corporation of a size similar to that of the Company and engaged in a similar business in the same community might reasonably be expected to conduct.

G. Tax Returns and Audits

Except as shown on Exhibit A to this Agreement, within the times and in the manner prescribed by law, the Company has filed all federal, state and local tax returns required by law and has paid all taxes, assessments and penalties shown thereon to be due and payable. The provisions for taxes reflected in the Balance Sheet are adequate for any and all federal, state and local taxes payable by the Company for the period ending on such date and for all prior periods, whether or not disputed. Except as shown on Exhibit A to this Agreement, there are no present disputes or claims or, to the knowledge of the Shareholders, threatened claims as to taxes of any nature payable by the Company and no waivers of statutes of limitations are in effect with respect to taxes that may be payable by the Company. The Company has not filed, and will not file on or before the Closing Date, any consent under Section 341(f) of the Internal Revenue Code of 1954, as amended. Except for satisfaction of the obligations shown on Exhibit E to this Agreement, no other consent or agreement is in effect which would restrict or adversely affect the right of the Company to transfer its assets, or of the transferee thereof to acquire such assets.

H. Real and Personal Property

There is set forth on Exhibits C or E to this Agreement (i) a complete and accurate legal description of each parcel of real property owned or held under lease by the Company or rights related thereto with a statement of the nature of

the Company's interest therein (including without limitation an indication of whether rights in such property are limited to the surface or to particular seams of coal, if the interest relates to less than the entire fee estate), (ii) a description of all buildings, fixtures and other improvements located on such property, (iii) the recording data necessary in order to locate the reference to any real property owned by Company in the records of the county where such property is located, and (iv) a schedule of all items of personal property owned or leased by, in the possession of, or used in connection with the business of the Company, with a statement of the nature of the Company's interest therein. There is set forth on Exhibit D to this Agreement a complete and accurate description of the McKinnon Lease between the State of Utah and the Estate under which the Company has been operating as a sublessee. Prior to the Closing Date the Company and the Estate shall execute the sublease under which the Company has operated since August 13, 1979 (including without limitation the 8% royalty which has been paid thereunder). The $50,000 limitation as to the indemnity obligation under Section 9 shall not apply to any claim by the Company's coal customers based on such Sublease. Exhibits C and D list all property ("the Mining Properties") owned by the Company, at any location, and by the Estate in Utah, and describe any areas or interests not owned or leased by the Company or the Estate within the confines of the Mining Properties, and all mortgages, royalties, overriding royalties, production payments, contingent or future interests and other burdens imposed upon any of the Mining Properties are shown on Exhibit E to this Agreement.

The leasehold interests held by the Company and the Estate in the Mining Properties are, and on the Closing Date will be, in full force and effect, and sufficient for the mining purposes contemplated thereunder, with all rentals, royalties and other obligations satisfied on a current basis and not subject to any jeopardy as to their continued existence by any actions or failure to take actions by the Company or the Estate. The fee interests held by the Company in the Mining Properties are sufficient for mining of coal, including without limitation exclusive access to such lands held by the fee interest for extracting coal and other minerals, use of the surface of such lands held by fee interest for uses compatible with mining and related purposes, rights to remove and sell coal and other minerals from such lands held by fee interest and exclusive access across and through such lands held by fee interest to the adjacent federal lands. The Mining Properties are free and clear of restrictions on or conditions to transfer or assignment, and of mortgages, liens, pledges, charges, encumbrances, security interests, equities, claims, easements, rights of way, covenants, conditions and restrictions, except (i) as listed on Exhibit E, (ii) the lien of current taxes not yet due and payable and (ii) possible minor matters that, in the aggregate, are not substantial in amount and do not materially detract from or interfere with the present or intended use of any of such assets or properties, or materially impair the Company's business operations. Notwithstanding the foregoing statement on current taxes, the Estate shall prior to the Closing Date have obtained all tax and other governmental approvals required for the transfer of the McKinnon Lease and shall indemnify Purchasers against claims attributable to the McKinnon Lease or the transfer thereof to the Purchasers, on the same basis as set forth in Section 9 hereof for the Shareholders, except that the $50,000 limitation shall not apply to such indemnity.

There are no currently pending or, to the knowledge of the Shareholders, threatened, condemnation or eminent domain proceedings, or sales in lieu thereof, involving partial or total taking of the Mining Properties. The

Shareholders and the Estate are not aware of any actual or threatened claim contrary to their title and interest in the Mining Properties or any basis for any such claim. Prior to the Closing Date, the Company and the Estate shall obtain the satisfactory evidence contemplated in Paragraph K of Section 5. All deeds, leases and other documents and instruments under which the Company or the Estate, in the case of the McKinnon Lease, claims title to or any interest in its real or personal property, copies of which have been made available to the Purchasers for their inspection, are valid and effective in accordance with their terms.

J. Contracts and Commitments

Except as set forth on Exhibit F to this Agreement, the Company has no (i) collective bargaining agreements or pending National Labor Relations Board petitions to represent any of its employees or any obligation to bargain with any labor organization which has been certified or recognized as a majority representative of any of its employees, (ii) agreements that contain any severance pay liabilities or obligations, (iii) bonus, deferred compensation, pension, profit-sharing, stock option, employee stock purchase or retirement plans, or any other employee benefit plans or arrangements, (iv) employment or consulting agreement, contract or commitment with an employee or individual consultant or any consulting agreement, contract or commitment with a consulting firm or other organization, (v) agreement of guarantee or indemnification running to any person or entity, (vi) agreement, contract or commitment containing any covenant limiting the freedom of Company to engage in any line of business or compete with any person or (vii) agreement, contract or commitment requiring the Company to utilize the services of any entity, firm or individual or to pay any commission, fee or other payment related to the business of the Company, including without limitation any payments in coal or other property. The Company has not received notice that any party to any agreement listed on Exhibit F intends to cancel or terminate any such agreement and the Shareholders know of no fact or circumstance which would entitle any party to any such agreement to cancel or terminate the same.

K. Trade Names, Trademarks, Copyrights, Patents and Trade Secrets

The Company does not own or have any right or license in any trade name (other than its corporate name), trademark, service mark, copyright, patent, invention, industrial model, process design, patent application or trade secret, nor is it now subject to a claim of infringement with regard to, or, to the knowledge of the Shareholders, infringing on, any trade name, trademark, service mark, copyright, patent or proprietary or personal right of any other person, firm or corporation.

L. Customers and Sales

The Shareholders have no information, nor are they aware of any facts, indicating that any customers of the Company intend to cease doing business with the Company or materially alter the amount of the business that they are presently doing with the Company, whether on account of the proposed acquisition of the Shares by the Purchasers or otherwise.

hereto prior to making any press release relating to this Agreement the transactions contemplated hereby, or termination hereof.

IN WITNESS WHEREOF, the parties hereto have duly executed this Agreement in multiple original copies on the day and year first above written.

SHAREHOLDERS — NO. OF SHARES

THE FETTEROLF GROUP, INC.
P.O. Box 84
Somerset, Pennsylvania 15501

By _____

_____
JOHN L. BELL
1351 Hogan Circle
Bloomington, Utah 84770

_____
CHARLES A. BASS
2022 N.W. Troost
Roseburg, Oregon 97470

NATOMAS MINERALS OF UTAH, INC.

By _____
Chairman & Chief Executive Officer

NATOMAS TRAIL MOUNTAIN COAL COMPANY

By _____
President

The representations regarding the Estate are true and correct and the McKinnon Lease shall be transferred as required herein, subject to the receipt of the necessary approvals.

THE ESTATE OF MYRON F. FETTEROLF

By _____
by _____
Attorney-in-fact

EXHIBIT C

Real and Personal Property

(1) Real estate owned in fee:

The following described land situated in Emery County, Utah:
Beginning at the southeast corner of the northwest quarter of the southeast quarter of Section 25, Township 17 South, Range 6 East, Salt Lake Base and Meridian, thence north 160 rods; thence east 44 rods, more or less, to the center line of Cottonwood Creek; thence in a southerly direction along the center line of said Cottonwood Creek to a point 76 rods, more or less, east of beginning; thence west 76 rods, more or less, to the point of beginning, containing 53.5 acres.

Subject to all reservations, restrictions, covenants, easements, conditions and rights of way appearing of record.

Mineral lease: Utah - 082996 covering the following described tracts each containing 40 acres in Emery County, Utah: the southwest quarter of the southeast quarter and the east half of the east half of the southeast quarter of Section 25, Township 17 South, Range 6 East, Salt Lake Base and Meridian.

(2) Buildings, fixtures and other improvements:

a) office building (including shop, bathhouse, dressing area, etc.),
b) tipple and adjacent building,
c) scale house,
d) scoop storage house,
e) switch house,
f) powder house,
g) fan house.

(3) Recording data for real estate owned in fee: Deed book volume 102, page 803.

(4) Personal property owned or leased:

(1) Allis Chalmers Shaker with 25 Horsepower Motor
(1) Belt Drive on Stacker Belt 25 Horsepower
(1) Big Sam Spray Machine
(1) Block Generator Building
(1) Bonanza Fan 8"
(1) Case Diesel High Lift Tractor
(3) Distribution Boxes
(1) Dodge Pickup 1979
(1) Emco Air Alert 300 Power Center
(1) Emco Air Alert 150 Power Center
(1) Emco Air Alert Section Power Center

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

SERIAL NUMBER

U-49332

COAL LEASE

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This lease, is entered into on FEB 18 1983 , by the United States of America, the lessor, the Bureau of Land Management, and

Natomas Minerals of Utah, Inc.
5970 So. Syracuse St., Ste 124
Englewood, CO 80111

, the lessee, and shall become effective on MAR 1 1983 , (effective date).

Sec. 1. STATUTES AND REGULATIONS--This lease is issued pursuant and subject to the terms and provisions of the Mineral Leasing Act of February 25, 1920, 41 Stat. 437, as amended, 30 U.S.C. Sections 181-263, hereinafter referred to as the Act; and of the Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. Section 1201, et seq., the Federal Coal Leasing Amendments Act of 1976, as amended, 90 Stat. 1083-1092, and, in the case of acquired lands, the Mineral Leasing Act for Acquired Lands of September 7, 1947, as amended, 30 U.S.C. 351-359, et seq. This lease is also subject to all regulations of the Secretary of the Interior (including, but not limited to, 30 CFR Part 211 and Chapter VII and 43 CFR Group 3400), which are now in force or (except as expressly limited herein) hereafter in force, and all of such regulations are made a part hereof.

WITNESSETH:

Sec. 2. RIGHTS OF LESSEE--The lessor, in consideration of any bonus paid (or to be paid if deferred), rents and royalties and other conditions hereinafter set forth, hereby grants and leases to the lessee the exclusive right and priviledge to mine and dispose of all coal in

T. 17 S., R. 6 E., SLM, Utah
Sec. 25, S½NW¼, W½SW¼, W½E½SW¼;
Sec. 26, SE¼NE¼, E½SW¼NE¼, E½SE¼, E½W½SE¼;
Sec. 35, lots 1, 2, SE¼NE¼, E½SW¼NE¼, E½SE¼, E½W½SE¼.

containing 641.47 acres, more or less, and subject to the conditions, limitations and prohibitions provided n this lease and in applicable acts and regulations, the right to construct all works, buildings, structures, equipment, and appliances which may be necessary and convenient for the mining and preparation of the coal for market, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted for a period of 20 years and so long thereafter as the condition of continued operation is met.

Sec. 3 DILIGENT DEVELOPMENT AND CONTINUED OPERATION--The lessee shall engage in the diligent development of the coal resources subject to the lease. After diligent development is achieved, the lessee shall maintain continued operation of the mine or mines on the leased lands. The terms diligent development and continued operation are defined in the applicable regulations in Titles 10, 30, and 43 of the Code of Federal Regulations.

Sec. 4. BOND--The lessee shall file with the appropriate Bureau of Land Management office a lease bond in the amount of $5,000.00 , for the use and benefit of the United States, to insure payment of deferred bonus payments, rentals and royalties and to insure compliance with all other items of this lease, the regulations and the Act (except for reclamation within the area covered by a surface mining permit issued under the permanent regulatory program by the regulatory authority) and, if appropriate, for the protection of the interests of the surface owners on the leased lands. An increase in the amount of the lease bond may be required by the lessor at any time during the life of the lease to reflect changed conditions.

Sec. 5. RENTAL--An annual rental of $3.00 for each acre or fraction thereof shall be paid in advance on or before the anniversary date of this lease. This section shall not be subject to revision except in the course of lease readjustment.

Sec. 6. PRODUCTION ROYALTY--The lessee shall pay a production royalty of 12½ percent of the value of coal produced by strip or auger mining methods and 8 percent of the value of coal produced by underground mining methods. The value of coal shall be determined as set forth in 30 CFR 211. Production royalties paid for a calendar month shall be reduced by the amount of any advance royalties paid under this lease to the extent that such advance royalties have not been used to reduce production royalties in a previous month. However, production royalties payable after the 20th year of the lease shall not be reduced by advance royalties paid during the first 20 years of the lease. Production royalties shall be payable the final day of the month succeeding the calendar month in which the coal is sold, unless otherwise specified in 30 CFR 211. The royalty rates provided in this section shall not be subject to revision except in the course of lease readjustment.

Sec. 7. ADVANCE ROYALTY--Upon request by the lessee, the District Mining Supervisor may accept, for a total of not more than 10 years, the payment of advance royalties in lieu of the condition of continued operation consistent with the regulations in 43 CFR 3473 and 30 CFR 211. The advance royalty shall be based on a percent of the value of a minimum number of tons which shall be determined in the manner established by the regulations in 43 CFR 3473.

Sec. 8. METHOD OF PAYMENTS--The lessee shall make rental payments to the appropriate Bureau of Land Management (BLM) office until production royalties become payable. Thereafter, all rentals, production royalties and advance royalties shall be paid to the appropriate office of the United States Geological Survey.

Sec. 9. EXPLORATION PLAN--The lessee shall not commence any exploration, except casual use, on the leased lands without an approved exploration plan. Exploration plans for leased lands covered by an approved mining permit shall be submitted to the Regional Director of the Office of Surface Mining in accordance with the regulations in 30 CFR Chapter VII. Exploration plans for leased lands not covered by an approved mining permit shall be submitted to the District Mining Supervisor in accordance with the regulations in 30 CFR 211.

Sec. 10. MINING PLAN--In accordance with the regulations in 30 CFR 211 and Chapter VII, the lessee shall submit a mining and reclamation plan not more than three years after the effective date of this lease. Mining operations shall not commence until after the mining and reclamation plan is approved. The mining and reclamation shall be conducted in accordance with the approved mining and reclamation plan. Exploration activities which were not included in the approved mining and reclamation plan require submittal of exploration plans in accordance with Section 9 of this lease.

Sec. 11. LOGICAL MINING UNIT (LMU)--This lease is automatically considered to be an LMU. This LMU may be enlarged, adjusted or diminished in accordance with the applicable regulations in Titles 10, 30, and 43 of the Code of Federal Regulations. The mining plan for the LMU shall require that the reserves of the LMU will be mined within a period of 40 years in accordance with 30 CFR 211 and 43 CFR 3400.0-5. The definition of LMU and LMU reserves and other applicable conditions are set forth in the regulations in 43 CFR 3400.0-5 and 3475, 30 CFR 211, and Title 10 of the Code of Federal Regulations.

Sec. 12. OPERATIONS ON LEASED LANDS--(a) In accordance with conditions of this lease, the exploration and mining and reclamation plans, the permit issued pursuant to 30 CFR Chapter VII, and all applicable acts and regulations, the lessee shall exercise reasonable diligence, skill, and care in all operations on leased lands.

(b) The lessee shall minimize to the maximum extent possible wasting of the coal deposits and other mineral and nonmineral resources, including but not limited to, surface resources which may be found in, upon, or under such lands.

Sec. 13. SPECIAL STATUTES--The lessee shall comply with the provisions of the Federal Water Pollution Control Act, 33 U.S.C. 1151-1175, and the Clean Air Act, 42 U.S.C. 7401, et seq.

Sec. 14. AUTHORIZATION OF OTHER USES AND DISPOSITION OF LEASED LANDS--(a) The lessor reserves the right to authorize other uses of the leased lands by regulation or by issuing, in addition to this lease, leases, licenses, permits, easements, or rights-of-way, including leases for the development of minerals other than coal under the Act. The lessor may authorize any other uses of the leased lands that do not unreasonably interfere with the exploration and mining operations of the lessee, and the lessee shall make all reasonable efforts to avoid interference with such authorized uses.

(b) The lessor reserves the right: (i) to sell or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the coal therein, or (ii) to dispose of any resource in such lands if such disposal will not unreasonably interfere with the exploration and mining operations of the lessee.

(c) If the leased lands have been or shall hereafter be disposed of under laws reserving to the United States the deposits of coal therein, the lessee shall comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such coal.

Sec. 15. EQUAL OPPORTUNITY CLAUSE--The lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and the rules, regulations and relevant orders of the Secretary of Labor.

Sec. 16. CERTIFICATION OF NONSEGREGATED FACILITIES--By entering into this lease, the lessee certifies that he does not and will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not and will not permit his employees to perform their services at any location under his control where segregated facilities are maintained. The lessee agrees that a breach of this certification is a violation of the Equal Opportunity clause of this lease. As used in this certification, the term "segregated facilities" means, but is not limited to, any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. Lessee further agrees that (except where lessee has obtained identical certifications from proposed contractors and subcontractors for specific time periods) lessee will obtain identical certifications from proposed contractors and subcontractors prior to award of contracts or subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that lessee will retain such certifications in lessee's files; and that lessee will forward the following notice to such proposed contractors and subcontractors (except where proposed contractor or subcontractor has submitted identical certifications for specific time periods). Notice to prospective contractors and subcontractors of requirement for certification of nonsegregated facilities. A Certification of Non-segregated Facilities, as required by the May 9, 1967 order (32 F.R. 7439, May 19, 1967) on Elimination of Segregated Facilities, by the Secretary of Labor, must be submitted prior to the award of a contract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. Certification may be submitted either for each contract and subcontract or for all contracts and subcontracts during a period (i.e., quarterly, semiannually, or annually).

Sec. 17. EMPLOYMENT PRACTICES--The lessee shall pay all wages due persons employed on the leased lands at least twice each month in lawful money of the United States. The lessee shall grant all miners and other employees complete freedom to purchase goods and service of their own choice. The lessee shall restrict the workday to not more than 8 hours in any one day for underground workers, except in case of emergency. The lessee shall employ no person under the age of 16 years in any mine below the surface. If the laws of the State in which the mine is situated prohibit the employment, in a mine below the surface, of persons of an age greater than 16 years, the lessee shall comply with those laws.

Sec. 18. MONOPOLY AND FAIR PRACTICES--The lessor reserves full authority to promulgate and enforce orders and regulations under the provisions of Sections 30 and 32 of the Act (30 U.S.C. Sections 187 and 189) necessary to insure that any sale of the production from the leased lands to the United States or to the public is at reasonable prices, to prevent monopoly, and to safeguard the public welfare, and such orders and regulations shall upon promulgation be binding upon the lessee.

Sec. 19. TRANSFERS--

[X] This lease may be transferred in whole or in part to any person, association or corporation qualified under 43 CFR 3472.1-1 to hold a lease.

[ ] This lease may only be transferred in whole or in part to another public body, or to a person who will mine the coal on behalf of and for the use of the public body, or to a person for the limited purpose of creating a security interest in favor of a lender who agrees to be obligated to mine the coal on behalf of the public body. The transferee must be qualified under 43 CFR 3472.

[ ] This lease may only be transferred in whole or in part to other small businessess qualifying under 13 CFR 121 and 43 CFR 3472.2-2(c).

Any transfer of this lease in whole or in part is subject to the procedures and requirements for approval in the relevant regulations in 43 CFR 3400. A transfer will become effective on the first day of the month following its approval by the authorized officer, or, if the transferee requests, the first day of the month of the approval.

Sec. 20. RELINQUISHMENT OF LEASE--The lessee may file a relinquishment of the entire lease, a legal subdivision or aliquot part thereof, but not less than 10 acres, or any bed of the coal deposits therein. The relinquishment shall be filed in triplicate with the authorized officer. Upon the determination by the authorized officer that the public interest shall not be impaired, that all accrued rentals and royalties have been paid and that all of the obligations of the lessee under the regulations and the lease terms have been met, the relinquishment shall be accepted effective the date filed.

Sec. 21. NONCOMPLIANCE--Any failure to comply with the conditions of this lease, the approved exploration and mining and reclamation plans, the regulations, or applicable acts, shall be dealt with in accordance with the procedures set forth in the regulations.

Sec. 22. WAIVER OF CONDITIONS--The lessor reserves the right to waive any breach of the conditions contained in this lease, except the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular breach prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 23. READJUSTMENT OF TERMS AND CONDITIONS--(a) The lease is subject to readjustment on the 20th year after the effective date and on each 10th year thereafter. In order that the lease may be readjusted as close as possible to the dates when it becomes subject to readjustment, the lessor may propose the terms of readjustment of any conditions of this lease, including rental and royalty rates, before the 20th year after the effective date and before each 10-year interval thereafter. The authorized officer shall notify the lessee whether he intends to readjust the terms and conditions of the lease and, if he intends to readjust, the nature of the readjustments in accordance with the regulations in 43 CFR 3451. Unless the lessee, within 60 days after receipt of the proposed readjusted terms, files with the lessor an objection to the proposed readjusted conditions or relinquishes the lease as of the effective date of the readjustment, the lessee shall be deemed conclusively to have agreed to such conditions.

(b) If the lessee files objections to the proposed readjusted conditions, the existing conditions shall remain in effect until there has been an agreement between the lessor and the lessee on the new conditions to be incorporated in the lease, or until the lessee has exhausted his rights of appeal under Section 31 of this lease, or until the lease is relinquished, except that the authorized officer may provide in the notice of readjusted lease terms that the readjustment or any part thereof is effective pending the outcome of the appeal. If the readjusted royalty provisions are subsequently rescinded or amended, the lessee shall be permitted to credit any excess royalty payments against royalties subsequently due to the lessor.

Sec. 24. DELIVERY OF PREMISES--Upon termination of this lease for any reason, or relinquishment of a part of this lease, the lessee shall deliver to the lessor in good order and condition all or the appropriate part of leased lands. Delivery of the leased lands shall include underground timbering and such other supports and structures as are necessary for the preservation of the mine or deposit, and shall be in accordance with all other applicable provisions of the regulations, including 30 CFR 211 and Chapter VII, for the completion of operations and abandonment.

Sec. 25. PROPRIETARY INFORMATION--Geological and geophysical data and information, including maps, trade secrets, and commercial and financial information which the lessor obtains from the lessee shall be treated in accordance with 43 CFR Part 2, 30 CFR 211.6 and other applicable regulations. Total lease reserve figures developed from this information will not be confidential.

Sec. 26. LESSEE'S LIABILITY TO LESSOR--(a) The lessee shall be liable to the United States for any damage suffered by the United States in any way arising from or connected with the lessee's activities and operations under this lease, except where damage is caused by employees of the United States acting within the scope of their authority.

(b) The lessee shall indemnify and hold harmless the United States from any and all claims arising from or connected with the lessee's activities and operations under this lease.

(c) In any case where liability without fault is imposed on the lessee pursuant to this section, and the damages involved were caused by the action of a third party, the rules of subrogation shall apply in accordance with the law of the jurisdiction where the damages occurred.

Sec. 27. INSPECTIONS AND INVESTIGATIONS--(a) All books and records maintained by the lessee showing information required by this lease or regulations must be kept current and in such manner that the books and records can be readily checked at the mine, upon request, by the Regional Director or District Mining Supervisor or their representative.

(b) The lessee shall permit any duly authorized officer or representative of the lessor at any reasonable time (1) to inspect or investigate the leased lands, the exploration and mining and reclamation operations, and all surface and underground improvements, works, machinery, and equipment, and all books and records pertaining to the lessee's obligations to the lessor under this lease and regulations and (2) to copy, and make extracts from any such books and records.

Sec. 28. UNLAWFUL INTEREST--No member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, either before or after he has qualified and during his continuance in office, and no officer, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(3), shall hold any share or part in this lease or derive any benefit therefrom. The provisions of Section 3741 of the Revised Statutes, as amended, 41 U.S.C. Section 22, and the Act of June 25, 1948, 62 Stat. 702, as amended, 18 U.S.C. Sections 431-433, relating to contracts, enter into and form a part of this lease insofar as they may be applicable.

Sec. 29. APPEALS--The lessee shall have the right to appeal (a) under 43 CFR 3000.4 from an action or decision of any official of the Bureau of Land Management (b) under 30 CFR Part 290 from an action, order, or decision of any official of the United States Geological Survey, or (c) under applicable regulation from any action or decision of any other official of the Department of the Interior arising in connection with this lease, including any action or decision pursuant to Section 23 of this lease with respect to the readjustment of conditions.

Sec. 30. DEFERRED BONUS--This lease is issued subject to the payment of $ 1,140,000 by the lessee as a deferred bonus. Payment of the deferred bonus by the lessee shall be made on a schedule specified in Section 31 (Special Stipulations) of this lease.

Sec. 31. SPECIAL STIPULATIONS-- The District Mining Supervisor shall mean the authorized representative of the Minerals Management Service and the Regional Director shall mean the authorized representative of the Office of Surface Mining. The Authorized Officer shall mean the State Director, Bureau of Land Management. The Authorized Officer of the Surface Management Agency shall mean the Forest Supervisor, Forest Service. The surface management agency for private surface shall be the Forest Service.

1. The Lessee will be responsible to comply with applicable Federal, State, and local laws and regulations.

2. In accordance with Sec. 523(b) of the "Surface Mining Control and Reclamation Act of 1977," surface mining and reclamation operations conducted on this lease are to conform with the requirements of this Act and are subject to compliance with Office of Surface Mining Regulations, or as applicable, a Utah program equivalent approved under cooperative agreement in accordance with Sec. 523(c) and final determination of suitability for mining. The United States Government does not warrant that the entire tract will be susceptible to mining.

3. The coal contained within the lease area and authorized for mining under this lease shall be extracted only by underground mining methods.

4. All support facilities, structures, equipment, and similar developments will be removed from the lease area within two years after the final termination of use of such facilities. All disturbed areas and those areas occupied by such facilities will be rehabilitated in accordance with an approved reclamation plan, 30 CFR 211 and the "Surface Mining Control and Reclamation Act of 1977" or approved Utah program as applicable.

5. (a) Before undertaking any activities that may disturb the surface of the leased lands, the Lessee may be required to conduct a cultural resource intensive field inventory in a manner specified by the Regional Director and the Authorized Officer of the surface managing agency on portions of the mine plan area and adjacent areas, or exploration plan area, that may be adversely affected by lease-related activities and which were not previously inventoried at such a level of intensity. The inventory shall be conducted by a qualified professional cultural resource specialist (i.e., archaeologist, historian, or historical architect, as appropriate), approved by the Authorized Officer of the surface managing agency and a report of the inventory and recommendations for protecting any cultural resources identified shall be submitted to the Regional Director (or the District Mining Supervisor if activities are associated with coal exploration outside an approved mining permit area) and the Authorized Officer of the surface managing agency. The Lessee shall undertake measures, in accordance with instructions from the Regional Director (or the District Mining Supervisor if activities are associated with coal exploration outside an approved mining permit area), to protect cultural resources on the leased land. The Lessee shall not commence the surface disturbing activities until permission to proceed is given by the Regional Director or the District Mining Supervisor as appropriate.

(b) The Lessee shall protect all cultural resource properties within the lease area from lease-related activities until the cultural resource mitigation measures can be implemented as part of an approved mining and reclamation plan or exploration plan.

(c) The cost of conducting the inventory, preparing reports, and carrying out mitigation measures shall be borne by the Lessee.

(d) If cultural resources are discovered during operations under this lease, the Lessee shall immediately bring them to the attention of the Regional Director (or the District Mining Supervisor as appropriate), and the Authorized Officer, Surface Management Agency. The Lessee shall not disturb such resources except as may be subsequently authorized by the Regional Director (or the District Mining Supervisor). Within two (2) working days of notification, the Regional Director (or the District Mining Supervisor, as appropriate) will evaluate or have evaluated any cultural resources discovered and will determine if any action may be required to protect or preserve such discoveries.

(e) All cultural resources shall remain under the jurisdiction of the United States until ownership is determined under applicable law.

6. Before undertaking any activities that may disturb the surface of the leased lands, the Lessee shall contact the Regional Director and Authorized Officer of the Surface Management Agency to determine whether the Lessee will be required to conduct a paleontological appraisal of the mine plan and adjacent areas, or exploration plan areas, that may be adversely affected by lease-related activities. If the Regional Director and Authorized Officer, Surface Management Agency, determines that one is necessary, the paleontological appraisal shall be conducted by a qualified paleontologist approved by the Authorized Officer of the surface management agency, using the published literature and, where appropriate, field appraisals for determining the possible existence of fossils of scientific significance. A report of the appraisal and recommendations for protecting any fossils of significant scientific interest on the leased lands so identified shall be submitted to and approved by the Regional Director and the Authorized Officer, Surface Management Agency. When necessary to protect and/or collect the fossils of significant scientific interest on the leased lands, the Lessee shall undertake the measures provided in the approval of the mining and reclamation plan or exploration plan.

(a) The Lessee shall not knowingly disturb, alter, destroy, or take any fossils of significant scientific interest, and shall protect all such fossils in conformance with the measures included in the approval of the mining and reclamation plan or exploration plan.

(b) The Lessee shall immediately bring any such fossils that might be altered or destroyed by his operation to the attention of the Regional Director or the District Mining Supervisor, as appropriate. Operations may continue as long as the fossil specimen or specimens would not be seriously damaged or destroyed by the activity. The Regional Director or the District Mining Supervisor, as appropriate, shall evaluate or have evaluated such discoveries brought to his attention and, within five (5) working days, shall notify the Lessee what action shall be taken with respect to such discoveries.

(c) All such fossils of significant scientific interest shall remain under the jurisdiction of the United States until ownership is determined under applicable law. Copies of all paleontological resource data generated as a result of the lease term requirements will be provided to the Regional Director or the District Mining Supervisor, as appropriate.

(d) These conditions apply to all such fossils of significant scientific interest discovered within the lease area whether discovered in the overburden, interburden, or coal seam or seams. Fossils of significant scientific interest do not include those fossils commonly encountered during underground mining operations such as ferns and dinosaur tracks. Skeletal remains shall be considered significant.

7. The Lessee shall, prior to entry upon the lease, conduct an intensive field inventory for threatened and endangered plant and/or animal species, bald or golden eagles, or migratory species of high Federal interest on those areas to be disturbed and/or impacted including the access routes to the lease area. The inventory shall be conducted by a qualified specialist(s) approved by the Authorized Officer, Surface Management Agency, and a report of the inventory and recommendation for the protection of these species submitted to and approved by the Authorized Officer, Surface Management Agency, and Regional Director or District Mining Supervisor as appropriate. An acceptable report of any findings shall include the specific location, distribution, and habitat requirements of the species. The Lessee shall protect these species within the lease area from any activities associated with operations conducted under the terms of the lease and shall undertake such protective measures as may be required by the Authorized Officer, Surface Management Agency, and Regional Director, or District Mining Supervisor as appropriate.

8. Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to conform with the publication "Suggested Practices for Raptor Protection on Powerlines" (Edison Electric Institute, 1975). When feasible, powerlines will be located at least 100 yards from public roads.

9. The Lessee shall provide for the suppression and control of fugitive dust on all haul roads, and at coal hauling, transportation, and storage facilities. The migration of road surfacing materials shall be controlled by watering, chemical treatment, or hard surfacing. Loss of gravel courses shall be periodically replaced.

10. In order to avoid surface disturbance on steep canyon slopes and the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specific locations approved by the Regional Director with the concurrence of the Authorized Officer, Surface Management Agency and the District Mining Supervisor.

11. Prior to mining, the Lessee shall perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. The study will be established in consultation with and approved by the Authorized Officer, Surface Management Agency, the Regional Director, and the District Mining Supervisor and shall be adequate to locate, quantify, and demonstrate the interrelationship of the geology, topography, surface hydrology, vegetation, and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

12. The Lessee shall establish a monitoring system to locate, measure, and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology, and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a sufficient number of points over the lease area. The monitoring shall be an extension of the baseline data and shall be conducted by a method approved by the Regional Director in consultation with and concurrence by the Authorized Officer, Surface Management Agency and District Mining Supervisor.

13. Underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to surface structures, and improvements, and (3) damage or alter the flow of perennial streams. The Lessee in his mining plan shall provide specific measures for the protection of escarpments. The Regional Director in consultation with and concurrence of the District Mining Supervisor and Authorized Officer, Surface Management Agency, shall approve such measures and may prescribe any additional measures to be employed such as mining methods, specify the amount of coal recovered, and determine any corrective measures considered necessary to assure that escarpment failure does not occur except at specifically approved locations, or that hazardous conditions are not created.

14. Existing surface improvements required for the surface uses of the lease area will need to be protected or maintained to provide for the post-mining continuance of the current land uses. Existing surface improvements whose utility may be lost or damaged as result of mining activities are to be replaced or restored.

15. The Lessee shall reclaim all areas disturbed as a result of mining and exploration operations to a land use capable of supporting the pre-mining levels of livestock grazing, big game winter range, and other wildlife habitat.

16. At the conclusion of the mining operation, or at the request of the Authorized Officer of the Surface Managing Agency, all damaged, disturbed, or displaced land monuments, accessories and appendages shall be replaced or restored in their original location (or at other locations that meet the needs of the land net, and as approved by the Authorized Officer of the Surface Managing Agency) and shall be done at the expense of the Lessee.

17. The Lessee will be responsible to replace any water lost or adversely affected by mining operations with water from an alternative source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, and livestock and wildlife use.

18. The Lessee will be required to reconstruct the road in Cottonwood Canyon from the mine site to Highway 29 in a manner agreeable to Emery County and the authorized officer of the Surface Management agencies. In the interim, until reconstruction is completed, traffic management requirements will be imposed on the existing road commensurate with the season of use, road conditions, and volumes of traffic.

19. The Lessee shall assure that mine facilities, parking areas, and equipment do not encroach on the Cottonwood Canyon Road (FDR #50041) nor interfere with traffic on this road.

20. Reasonable stock driveway access must be provided and maintained to the Trail Mountain cattle and horse allotment.

21. The Cottonwood Canyon Road shall be maintained in such a manner so as to provide suitable forest access as well as coal haulage. Because of the narrow confines of Cottonwood Canyon, all future and existing facilities such as power, telephone, water and sewer lines, coal conveyors, and similar facilities, shall be constructed and/or maintained by the Lessee so as to not interfere with the Cottonwood Canyon Road or access provided thereby.

22. Deferred Bonus Payment Schedule:

The balance of the bonus bid shall be paid in equal annual installments in the amount of $285,000.00 due and payable on the next four anniversary dates of this lease.

If the lease is relinquished or otherwise cancelled or terminated, the unpaid remainder of the bid shall be immediately payable to the United States.

THE UNITED STATES OF AMERICA

By Richard D. Robison

STATE DIRECTOR

(Title)

FEB 18 1983
(Date)

WITNESS TO SIGNATURE OF LESSEE

Sally J Magnuse

Diana L. Peterson

Gary E. Gray

Dean V. Madsen
(Signature of Lessee)

J. J. Obert
(Signature of Lessee)

John J. Schoche

# State of Utah
*School and Institutional*
TRUST LANDS ADMINISTRATION

Michael O. Leavitt
Governor
David T. Terry
Director

355 West North Temple
3 Triad Center, Suite 400
Salt Lake City, Utah 84180-1204
801-538-5508
801-355-0922 (Fax)


February 7, 1996

Interwest Mining Company
Scott M. Child
One Utah Center, Suite 2000
Salt Lake City, UT 84140-0020

Dear Mr. Child:

RE: ML 22603--Coal

Please be advised that the Director on January 31, 1996, approved and accepted your request for relinquishment of the above-numbered lease.

I trust this information will be sufficient for your needs.

Sincerely,

JOHN T. BLAKE
MINERAL RESOURCES SPECIALIST

tdw

CC: D. BAKER
D. JENSE
D. LAURISKI
S. KOCHEVAR
C. POLLASTRO
[illegible]

One Utah Center, Suite 2000
Salt Lake City, Utah 84140-0020
(801) 220-4616 • FAX (801) 220-4725

INTERWEST MINING COMPANY

*A Subsidiary of PacifiCorp*

***CERTIFIED MAIL***
***RETURN RECEIPT REQUESTED***

January 19, 1996

Mr. John T. Blake
Minerals Resources Specialist
**State of Utah**
**School and Institutional Trust Lands Administration**
355 West North Temple
3 Triad Center, Suite 400
Salt Lake City, Utah 84180-1204

***RE: State Coal Lease ML-22603 - Trail Mountain Mine, Emery County, Utah***

Dear John:

We're in receipt of your letter dated December 27, 1995, together with the lease readjustment originals of ML-22603. After our review of the readjusted lease terms and the overall disposition of this lease, Interwest Mining Company on the behalf of PacifiCorp, hereby declines the lease readjustment as there is no further interest in continuing the lease.

Therefore, this written notice is given in response to your letter of December 27, 1995, and in accordance with the provisions of Articles II and XI of the existing lease, wherein PacifiCorp, (1) does not accept the terms and conditions of the readjusted lease, and (2) hereby relinquishes state lease ML-22603 in its entirety effective as of December 31, 1995.

We have appreciated the opportunity to work with the School and Institutional Trust Lands Administration in connection with this lease and look forward to having the opportunity to work with you again in the future. Returned with this letter are the original lease readjustments. Should you have questions or concerns, please contact me at 801-220-4612.

Sincerely,

Scott M. Child
Property Management Administrator

Enclosures

SMC12\UTLAND96 002

cc: IMC w/o copy encl. - D.W. Jense, S. Kochevar, G. Takenaka
EWEST w/o copy encl. - L. LaFrentz, D. Lauriski, V. Payne, C. Pollastro

...Third Road

...MS L:_____

MINERAL LEASE APPLICATION

NO 22603

MINERAL LEASE NO _____
GRANT: Solid

# Utah State Lease for
# COAL

THIS INDENTURE OF LEASE AND AGREEMENT entered into in duplicate this 11th day of February, 19 65 by and between the STATE LAND BOARD, acting on behalf of the State of Utah, hereinafter called the Lessor, and

WILLIAM H. McKINNON
1222 South Main Street
Salt Lake City, Utah 84101

party of the second part, hereinafter called the Lessee, under and Pursuant to Title 65, Utah Code Annotated, 1953.

WITNESSETH: That the Lessor, in consideration of the rents and royalties to be paid and the covenants to be observed by the Lessee, as hereinafter set forth, does hereby grant and lease to the Lessee the exclusive right and privilege to mine, remove, and dispose of all of the said minerals in, upon, or under the following described tract of land situated in Emery County, State of Utah, to-wit:

All of Section Thirty-six (36), Township Seventeen (17) South, Range Six (6) East, Salt Lake Meridian.,

containing a total of 640.00 acres, more or less, together with the right to use and occupy so much of the surface of said land as may be required for all purposes reasonably incident to the mining, removal, and disposal of said minerals, according to the provisions of this lease, for the period ending ten years after the first day of January next succeeding the date hereof and as long thereafter as said minerals may be produced in commercial quantities from said lands, or Lessee shall continue to make the payments required by Article III hereof, upon condition that at the end of each twenty (20) year period succeeding the first day of the year in which this lease is issued, such readjustments of terms and conditions may be made as the Lessor may determine to be necessary in the interest of the State.

## ARTICLE I

This lease is granted subject in all respects to and under the conditions of the laws of the State of Utah and existing rules and regulations and such operating rules and regulations as may be hereafter approved and adopted by the State Land Board.

## ARTICLE II

This lease covers only the mining, removal, and disposal of the minerals specified in this lease, but the Lessee shall promptly notify the the Lessor of the discovery of any minerals excepting those enumerated herein.

## ARTICLE III

The Lessee, in consideration of the granting of the rights and privileges aforesaid, hereby covenants and agrees as follows:

FIRST. To pay to the Lessor as rental for the land covered by this lease the sum of fifty (50) cents per acre per annum. All such annual payments of rental shall be made in advance on the 2nd day of January of each year, except the 1965 rental which is payable on the execution of this lease. All rentals shall be credited against royalties for the year in which they accrue.

SECOND: To pay to Lessor quarterly, on or before the 15th day of the month succeeding each quarter, royalty

(a) at the rate of 15¢ per ton of 2000 lbs. of coal produced from the leased premises and sold or otherwise disposed of, or

(b) at the rate prevailing at the beginning of the quarter for which payment is being made, for federal leases of land of similar character under coal leases issued by the United States in that area,

whichever is higher, and, commencing with the year beginning the January 1 following two years from the date hereof, to pay annual royalty of at least $1.00 multiplied by the number of acres herein leased regardless of actual production, provided that Lessor may, at any time after the tenth anniversary date hereof, increase the minimum annual royalty by not to exceed 50%.

Exhibit A-1

STATE OF UTAH
STATE LAND BOARD

By _____

_____

_____

LESSEE'S INDIVIDUAL ACKNOWLEDGEMENT

STATE OF UTAH
COUNTY OF } ss.

On the _____ day of _____ 19____ personally appeared before me _____

the signer of the above instrument, who duly acknowledged to me that _____ executed the same.

Given under my hand and seal this _____ day of _____ 19____

My commission Expires:

_____
Notary Public, residing at:

LESSEE'S CORPORATE ACKNOWLEDGEMENT

STATE OF UTAH
COUNTY OF } ss.

On the _____ day of _____ 19____ personally appeared before me _____

who being duly sworn did say that he is an officer of _____ and that said instrument was

in behalf of said corporation by resolution of its Board of Directors, and said _____ ac-

knowledged to me that said corporation executed the same.

Given under my hand and seal this _____ day of _____ 19____

My commission Expires:

_____
Notary Public, residing at:

STATE OF UTAH
COUNTY OF SALT LAKE } ss.

On the 22 day of March 19[illegible] personally appeared before me Max C. Gardner, who being by me duly sworn did say that he is the Director of the State Land Board of the State of Utah and that said instrument was signed in behalf of said Board by resolution of the Board, and said Max C. Gardner acknowledged to me that said Board executed the same in behalf of the State of Utah.

Given under my hand and seal this 22 day of March 19[illegible]

My commission Expires:
1-10-48

_____
Notary Public, residing at:

Exhibit A

# APPENDIX 4-2 (L)

## Federal Coal Lease U-64375

## Lease Permit Application

# United States Department of the Interior

BUREAU OF LAND MANAGEMENT
UTAH STATE OFFICE
324 SOUTH STATE, SUITE 301
SALT LAKE CITY, UTAH 84111-2303

TAKE PRIDE IN AMERICA

IN REPLY REFER TO
3425
UTU-64375
(U-942)

SEP 18 1990

CERTIFIED MAIL--Return Receipt Requested

Beaver Creek Coal Company
1305 S. Carbon Avenue
Price, Utah 84501

DECISION

Coal Lease
UTU-64375

Bond Accepted
Lease Issued

On August 15, 1990, coal lease bond U 8001367 in the amount of $4,891,505 with Beaver Creek Coal Company, as principal, and United Pacific Insurance Company, as surety, was filed in this office to provide bond coverage for coal lease UTU-64375. The bond has been examined, found to be satisfactory, and is accepted effective August 15, the date of filing.

Pursuant to the Lease By Application Coal Sale held June 28, 1990, the bid of Beaver Creek Coal Company for the Trail Mountain Tract, assigned Serial No. UTU-64375, was determined to be the high bid. Satisfactory evidence of the qualifications and holdings of Beaver Creek Coal Company has been filed; therefore, coal lease UTU-64375 is hereby issued effective October 1, 1990.

Chief, Minerals
Adjudication Section

Enclosure
Coal Lease UTU-64375

Form 3400-12
April 1986)

# UNITED STATES
# DEPARTMENT OF THE INTERIOR
# BUREAU OF LAND MANAGEMENT

## COAL LEASE

Serial Number

UTU-64375

ART I. LEASE RIGHTS GRANTED

his lease, entered into by and between the UNITED STATES OF AMERICA, hereinafter called lessor, through the Bureau of Land Management, and *Name and Address)*

Beaver Creek Coal Company
1305 S. Carbon Avenue
Price, Utah 84501

reinafter called lessee, is effective *(date)* OCT 1 1990, for a period of 20 years and for so long thereafter as coal is produced in commercial antities from the leased lands, subject to readjustment of lease terms at the end of the 20th lease year and each 10-year period thereafter.

c. 1. This lease is issued pursuant and subject to the terms and provisions of the:

Mineral Lands Leasing Act of 1920, Act of February 25, 1920, as amended, 41 Stat. 437, 30 U.S.C. 181-287, hereinafter referred to as the Act;

Mineral Leasing Act for Acquired Lands, Act of August 7, 1947, 61 Stat. 913, 30 U.S.C. 351-359;

d to the regulations and formal orders of the Secretary of the Interior which are now or hereafter in force, when not inconsistent with the express d specific provisions herein.

c. 2. Lessor, in consideration of any bonuses, rents, and royalties to be paid, and the conditions and covenants to be observed as herein set forth, reby grants and leases to lessee the exclusive right and privilege to drill for, mine, extract, remove, or otherwise process and dispose of the coal posits in, upon, or under the following described lands:

T. 17 S., R. 6 E., SLM, Utah
Sec. 26, S½SW¼, W½SW¼SE¼;
Sec. 27, S½S½;
Sec. 34, all;
Sec. 35, lots 3 and 4, W½SW¼NE¼, S½NW¼, SW¼, W½W½SE¼.

T. 18 S., R. 6 E., SLM, Utah
Sec. 1, lots 1-8, S½N½, E½NE¼SW¼, E½NW¼NE¼SW¼, N½NW¼NE¼SE¼, N½NW¼SE¼;
Sec. 2, lots 1-8, S½N½, N½NE¼SW¼, N½SW¼NE¼SW¼, SE¼NE¼SW¼, NW¼NE¼SE¼, N½SW¼NE¼SE¼, N½NW¼SE¼, N½S½NW¼SE¼;
Sec. 3, lots 1, 2, and 8, NE¼SE¼NE¼.
T. 18, S., R. 7 E., SLM, Utah
Sec. 6, lots 4-7, W½SE¼NW¼, W½E½SW¼.

taining 2,630.81 acres, more or less, together with the right to construct such works, buildings, plants, structures, equipment and appliances the right to use such on-lease rights-of-way which may be necessary and convenient in the exercise of the rights and privileges granted, subject to conditions herein provided.

IT II TERMS AND CONDITIONS

. 1. (a) RENTAL RATE - Lessee shall pay lessor rental annually and dvance for each acre or fraction thereof during the continuance of lease at the rate of $ 3.00 for each lease year.

RENTAL CREDITS - Rental shall not be credited against either luction or advance royalties for any year.

2. (a) PRODUCTION ROYALTIES - The royalty shall be 12½ & 8 per- of the value of the coal as set forth in the regulations. Royalties are to lessor the final day of the month succeeding the calendar month hich the royalty obligation accrues.

ADVANCE ROYALTIES - Upon request by the lessee, the authorized er may accept, for a total of not more than 10 years, the payment of ance royalties in lieu of continued operation, consistent with the l ns. The advance royalty shall be based on a percent of the a minimum number of tons determined in the manner ed by the advance royalty regulations in effect at the time the requests approval to pay advance royalties in lieu of continued tion.

. BONDS - Lessee shall maintain in the proper office a lease bond e amount of $ ** The authorized officer may require an ase in this amount when additional coverage is determined opriate.

** $4,891,505.00

Sec. 4. DILIGENCE - This lease is subject to the conditions of diligent development and continued operation, except that these conditions are excused when operations under the lease are interrupted by strikes, the elements, or casualties not attributable to the lessee. The lessor, in the public interest, may suspend the condition of continued operation upon payment of advance royalties in accordance with the regulations in existence at the time of the suspension. Lessee's failure to produce coal in commercial quantities at the end of 10 years shall terminate the lease. Lessee shall submit an operation and reclamation plan pursuant to Section 7 of the Act not later than 3 years after lease issuance.

The lessor reserves the power to assent to or order the suspension of the terms and conditions of this lease in accordance with, inter alia, Section 39 of the Mineral Leasing Act, 30 U.S.C. 209.

Sec. 5. LOGICAL MINING UNIT (LMU) - Either upon approval by the lessor of the lessee's application or at the direction of the lessor, this lease shall become an LMU or part of an LMU, subject to the provisions set forth in the regulations.

The stipulations established in an LMU approval in effect at the time of LMU approval will supersede the relevant inconsistent terms of this lease so long as the lease remains committed to the LMU. If the LMU of which this lease is a part is dissolved, the lease shall then be subject to the lease terms which would have been applied if the lease had not been included in an LMU.

Sec. 6. DOCUMENTS, EVIDENCE AND INSPEC - At such times and in such form as lessor may prescribe, lessee shall furnish detailed statements showing the amounts and quality of all products removed and sold from the lease, the proceeds therefrom, and the amount used for production purposes or unavoidably lost.

shall keep open at all reasonable times for the inspection of any authorized officer of lessor, the leased premises and all surface and underground improvements, works, machinery, ore stockpiles, equipment, and all books, accounts, maps, and records relative to operations, surveys, or investigations on or under the leased lands.

Lessee shall allow lessor access to and copying of documents reasonably necessary to verify lessee compliance with terms and conditions of the lease.

While this lease remains in effect, information obtained under this section shall be closed to inspection by the public in accordance with the Freedom of Information Act (5 U.S.C. 552).

Sec. 7. DAMAGES TO PROPERTY AND CONDUCT OF OPERATIONS - Lessee shall comply at its own expense with all reasonable orders of the Secretary, respecting diligent operations, prevention of waste, and protection of other resources.

Lessee shall not conduct exploration operations, other than casual use, without an approved exploration plan. All exploration plans prior to the commencement of mining operations within an approved mining permit area shall be submitted to the authorized officer.

Lessee shall carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health, or property, and prevention of waste, damage or degradation to any land, air, water, cultural, biological, visual, and other resources, including mineral deposits and formations of mineral deposits not leased hereunder, and other land uses or users. Lessee shall take measures deemed necessary by lessor to accomplish the intent of this lease term. Such measures may include, but are not limited to, modification to proposed design of facilities, timing of operations, and specification of interim and final reclamation procedures. Lessor reserves to itself the right to lease, sell, or otherwise dispose of the surface or other mineral deposits in the lands and the right to continue existing uses and to authorize future uses upon or in the leased lands, including issuing leases for mineral deposits not covered hereunder and approving easements or rights-of-way. Lessor shall condition such uses to prevent unnecessary or unreasonable interference with rights of lessee as may be consistent with concepts of multiple use and multiple mineral development.

Sec. 8. PROTECTION OF DIVERSE INTERESTS, AND EQUAL OPPORTUNITY - Lessee shall: pay when due all taxes legally assessed and levied under the laws of the State or the United States; accord all employees complete freedom of purchase; pay all wages at least twice each month in lawful money of the United States; maintain a safe working environment in accordance with standard industry practices; restrict the workday to not more than 8 hours in any one day for underground workers, except in emergencies; and take measures necessary to protect the health and safety of the public. No person under the age of 16 years shall be employed in any mine below the surface. To the extent that laws of the State in which the lands are situated are more restrictive than the provisions in this paragraph, then the State laws apply.

Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and the rules, regulations, and relevant orders of the Secretary of Labor. Neither lessee nor lessee's contractors shall maintain segregated facilities.

Sec. 9. (a) TRANSF

☒ This lease may be transferred in whole or in part to any person, association or corporation qualified to hold such lease interest.

☐ This lease may be transferred in whole or in part to another public body or to a person who will mine the coal on behalf of, and for the use of, the public body or to a person who for the limited purpose of creating a security interest in favor of a lender agrees to be obligated to mine the coal on behalf of the public body.

☐ This lease may only be transferred in whole or in part to another small business qualified under 13 CFR 121.

Transfers of record title, working or royalty interest *must* be approved in accordance with the regulations.

(b) RELINQUISHMENT - The lessee may relinquish in writing at any time all rights under this lease or any portion thereof as provided in the regulations. Upon lessor's acceptance of the relinquishment, lessee shall be relieved of all future obligations under the lease or the relinquished portion thereof, whichever is applicable.

Sec. 10. DELIVERY OF PREMISES, REMOVAL OF MACHINERY, EQUIPMENT, ETC. - At such time as all portions of this lease are returned to lessor, lessee shall deliver up to lessor the land leased, underground timbering, and such other supports and structures necessary for the preservation of the mine workings on the leased premises or deposits and place all workings in condition for suspension or abandonment. Within 180 days thereof, lessee shall remove from the premises all other structures, machinery, equipment, tools, and materials that it elects to or as required by the authorized officer. Any such structures, machinery, equipment, tools, and materials remaining on the leased lands beyond 180 days, or approved extension thereof, shall become the property of the lessor, but lessee shall either remove any or all such property or shall continue to be liable for the cost of removal and disposal in the amount actually incurred by the lessor. If the surface is owned by third parties, lessor shall waive the requirement for removal, provided the third parties do not object to such waiver. Lessee shall, prior to the termination of bond liability or at any other time when required and in accordance with all applicable laws and regulations, reclaim all lands the surface of which has been disturbed, dispose of all debris or solid waste, repair the offsite and onsite damage caused by lessee's activity or activities incidental thereto, and reclaim access roads or trails.

Sec. 11. PROCEEDINGS IN CASE OF DEFAULT - If lessee fails to comply with applicable laws, existing regulations, or the terms, conditions and stipulations of this lease, and the noncompliance continues for 30 days after written notice thereof, this lease shall be subject to cancellation by the lessor only by judicial proceedings. This provision shall not be construed to prevent the exercise by lessor of any other legal and equitable remedy, including waiver of the default. Any such remedy or waiver shall not prevent later cancellation for the same default occurring at any other time.

Sec. 12. HEIRS AND SUCCESSORS-IN-INTEREST - Each obligation of this lease shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 13. INDEMNIFICATION - Lessee shall indemnify and hold harmless the United States from any and all claims arising out of the lessee's activities and operations under this lease.

Sec. 14. SPECIAL STATUTES - This lease is subject to the Clean Water Act (33 U.S.C. 1252 et. seq.), the Clean Air Act (42 U.S.C. 4274 et. seq.), and to all other applicable laws pertaining to exploration activities, mining operations and reclamation, including the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et. seq.).

15. SPECIAL STIPULATIONS -

ec. 15. SPECIAL STIPULATIONS (Cont'd.) -

This coal lease is subject to termination if the lessee is determined at the time of issuance to be in noncompliance with Section 2(a)2(A) of the Mineral Leasing Act.

- SEE ATTACHED STIPULATIONS -

THE UNITED STATES OF AMERICA

Beaver Creek Coal Company
pany or Lessee Name

President (Signature of Lessee)

(Title)

AUG 1 9 1990
(Date)

By DEPARTMENT OF THE INTERIOR
Bureau of Land Management

(Signing Officer)

Chief, Minerals Adjudication Section
(Title)

SEP 18 1990
(Date)

8 U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any fictitious or fraudulent statements or representations as to any matter within its jurisdiction.

orm does not constitute an information collection as defined by 44 U.S.C. 3502 and therefore does not require OMB approval.

1. The Regulatory Authority shall mean the State Regulatory Authority pursuant to a cooperative agreement approved under 30 CFR Part 745 or in the absence of a cooperative agreement, Office of Surface Mining. The authorized officer shall mean the State Director, Bureau of Land Management. The authorized officer of the Surface Management Agency shall mean the Forest Supervisor, Forest Service. Surface Management Agency for private surface is the Bureau of Land Management. For adjoining private lands with Federal minerals and which primarily involve National Forest Service issues, the Forest Service will have the lead for environmental analysis and, when necessary, documentation in an environmental assessment or environmental impact statement.

2. The authorized officers of the Bureau of Land Management, Office of Surface Mining (Regulatory Authority), and the Surface Management Agency (Forest Service) respectively, shall coordinate, as practical, regulation of mining operations and associated activities on the lease area.

3. In accordance with Sec. 523(b) of the "Surface Mining Control and Reclamation Act of 1977," surface mining and reclamation operations conducted on this lease are to conform with the requirements of this Act and are subject to compliance with Office of Surface Mining regulations, or as applicable, an equivalent Utah program approved under a cooperative agreement in accordance with Sec. 523(c). The United States Government does not warrant that the entire tract will be susceptible to mining.

4. Federal Regulations 43 CFR 3400 pertaining to Coal Management make provisions for the Surface Management Agency, the surface of which is under the jurisdiction of any Federal agency other than the Department of the Interior, to consent to leasing and to prescribe conditions to insure the use and protection of the lands. All or part of this lease contain lands the surface of which are managed by the United States Department of Agriculture, Forest Service Manti-LaSal National Forest.

The following stipulations pertain to the lessee responsibility for mining operations on the lease area and on adjacent areas as may be specifically designated on National Forest System lands.

5. Before undertaking activities that may disturb the surface of previously undisturbed leased lands, the lessee may be required to conduct a cultural resource inventory and a paleontological appraisal of the areas to be disturbed. These studies shall be conducted by qualified professional cultural resource specialists or qualified paleontologists, as appropriate, and a report prepared itemizing the findings. A plan will then be submitted making recommendations for the protection of or measures to be taken to mitigate impacts for identified cultural or paleontological resources.

If cultural resources or paleontological remains (fossils) of significant scientific interest are discovered during operations under this lease, the lessee prior to disturbance shall immediately bring them to the attention of the appropriate authorities. Paleontological remains of significant scientific interest do not include leaves, ferns, or dinosaur tracks commonly encountered during underground mining operations.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

6. If there is reason to believe that threatened or endangered (T&E) species of plants or animals, or migratory bird species of high Federal interest occur in the area, the lessee shall be required to conduct an intensive field inventory of the area to be disturbed and/or impacted. The inventory shall be conducted by a qualified specialist and a report of findings will be prepared. A plan will be prepared making recommendations for the protection of these species or action necessary to mitigate the disturbance.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the lessee.

7. The lessee shall be required to perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. Existing data may be used if such data is adequate for the intended purposes. The study shall be adequate to locate, quantify, and demonstrate the inter-relationship of the geology, topography, surface hydrology, vegetation, and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

8. Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to provide adequate protection for raptors and other large birds. When feasible, powerlines will be located at least 100 yards from public roads.

9. The limited area available for mine facilities at the coal outcrop, steep topography, adverse winter weather, and physical limitations on the size and design of the access road, are factors which will determine the ultimate size of the surface area utilized for the mine. A site specific environmental analysis will be prepared for each new mine site development and for major modifications to existing developments to examine alternatives and mitigate conflicts.

10. Consideration will be given to site selection to reduce adverse visual impacts. Where alternative sites are available, and each alternative is technically feasible, the alternative involving the least damage to the scenery and other resources shall be selected. Permanent structures and facilities will be designed and screening techniques employed to reduce visual impacts and, where possible, achieve a final landscape compatible with the natural surroundings. The creation of unusual, objectionable, or unnatural land forms and vegetative landscape features will be avoided.

11. The lessee shall be required to establish a monitoring system to locate, measure, and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the lease area. The monitoring shall incorporate and be an extension of the baseline data.

12. The lessee shall provide for the suppression and control of fugitive dust on haul roads and at coal handling and storage facilities. On Forest Development Roads (FDR), lessees may perform their share of road maintenance by a commensurate share agreement if a significant degree of traffic is generated that is not related to their activities.

13. Except at specifically approved locations, underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would: (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to existing surface structures, or (3) damage or alter the flow of perennial streams. The lessee shall provide specific measures for the protection of escarpments, and determine corrective measures to assure that hazardous conditions are not created.

14. In order to avoid surface disturbance on steep canyon slopes and to preclude the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specifically approved locations.

15. If removal of timber is required for clearing of construction sites, etc., such timber shall be removed in accordance with the regulations of the surface management agency.

16. The coal contained within, and authorized for mining under this lease, shall be extracted only by underground mining methods.

17. Existing Forest Service owned or permitted surface improvements will need to be protected, restored, or replaced to provide for the continuance of current land uses.

18. In order to protect big game wintering areas, elk calving and deer fawning areas, sagegrouse strutting areas, and other critical wildlife habitat and/or activities, specific surface uses outside the mine development area may be curtailed during specific periods of the year.

19. Support facilities, structures, equipment, and similar developments will be removed from the lease area within 2 years after the final termination of use of such facilities. This provision shall apply unless the requirement of Section 10 of the lease form is applicable. Disturbed areas and those areas previously occupied by such facilities will be stabilized and rehabilitated, drainages reestablished, and the areas returned to a premining land use.

20. The lessee at the conclusion of the mining operations, or at other times as surface disturbance related to mining may occur, will replace all damaged, disturbed, or displaced corner monuments (section corners, quarter corners, etc.), their accessories and appendages (witness trees, bearing trees, etc.), or restore them to their original condition and location, or at other locations that meet the requirements of the rectangular surveying system. This work shall be conducted at the expense of the lessee by a professional land surveyor registered in the State of Utah and to the standards and guidelines found in the manual of surveying instruction, U.S. Department of the Interior.

21. The lessee at his expense will be responsible to replace any surface water identified for protection that may be lost or adversely affected by mining operations with water from an alternate source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, livestock and wildlife use, or other land uses.

22. The lessee must comply with all the rules and regulations of the Secretary of Agriculture set forth at Title 36, Chapter II, of the Code of Federal Regulations governing the use and management of the National Forest System (NFS) when not inconsistent with the rights granted by the Secretary of the Interior in the lease. The Secretary of Agriculture's rules and regulations must be complied with for (1) all use and occupancy of the NFS prior to approval of a permit/operation plan by the Secretary of the Interior, (2) uses of all existing improvements, such as Forest Development Roads, within and outside the area licensed, permitted or leased by the Secretary of the Interior, and (3) use and occupancy of the NFS not authorized by a permit/operation plan approved by the Secretary of the Interior.

All matters related to this stipulation are to be addressed to:

Forest Supervisor
Manti-LaSal National Forest
599 West Price River Drive
Price, Utah 84501

Telephone No.: 801-637-2817

who is the authorized representative of the Secretary of Agriculture.

GRANT: **PL 105 Multiple**

# UTAH STATE LEASE FOR COAL
# ML 51191-OBA

## COTTONWOOD COMPETITIVE LEASING UNIT
## PARCEL #1 (REVERSIONARY TRACT)

THIS COAL MINING LEASE AND AGREEMENT (the "Lease") is entered into and executed in duplicate as of January 18, 2008 (the "Effective Date") by and between the STATE OF UTAH, acting by and through the SCHOOL AND INSTITUTIONAL TRUST LANDS ADMINISTRATION, 675 East 500 South, Suite 500, Salt Lake City, Utah 84102 ("Lessor"), and

**Ark Land Company**
**One CityPlace Drive - Suite 300**
**St. Louis, MO 63141**

having a business address as shown above ("Lessee").

WITNESSETH:

That the State of Utah, as Lessor, in consideration of the rentals, royalties, and other financial consideration paid or required to be paid by Lessee, and the covenants of Lessee set forth below, does hereby GRANT AND LEASE to Lessee the exclusive right and privilege to explore for, drill for, mine, remove, transport, convey, cross-haul, commingle, and sell the coal located within the boundaries of the following-described tract of land located in Emery County, State of Utah:

PARCEL 1 (Cottonwood Coal Exchange Tract - Partial)

Township 17 South, Range 6 East, SLB&M
Section 2: SW4
Section 3: Lots 1 thru 12, SE4 (All)
Section 4: Lots 1, 2, S2NE4, SE4
Section 9: E2, E2W2
Section 10: Lots 1 thru 8, E2 (All)
Section 11: All
Section 12: W2W2
Section 13: W2W2
Section 14: Lots 1 thru 4, E2, NW4 (All)
Section 15: Lots 1 thru 12, NE4 (All)
Section 16: NE4NW4
Section 20: E2E2
Section 21: All
Section 22: All
Section 23: Lots 1 thru 12, NE4 (All)
Section 24: W2W2
Section 25: N2NW4
Section 26: N2NE4, W2SW4NE4, NW4, N2SW4, W2NW4SE4

Section 27: N2, N2S2
Section 28: N2, N2SW4, SE4
Section 29: NE4

Containing 8,203.87 acres, more or less.

Together with the right and privilege to make use of the surface (but only to the extent owned by Lessor) and subsurface of the Leased Premises for uses incident to the mining of coal by Lessee on the Leased Premises or on other lands under the control of Lessee or mined in connection with operations on the Leased Premises, including, but not limited to, conveying, storing, loading, hauling, commingling, cross-hauling, and otherwise transporting coal; excavating; removing, stockpiling, depositing and redepositing of surface materials; and the subsidence, mitigation, restoration and reclamation of the surface.

This Coal Mining Lease and Agreement is subject to, and Lessee hereby agrees to and accepts, the following covenants, terms, and conditions:

1. LEASED MINERALS.

1.1 Coal. This mineral lease covers coal, which shall mean and include black or brownish-black solid fossil fuels that have been subjected to the natural processes of coalification, and which fall within the classification of coal by rank as anthracitic, bituminous, sub-bituminous, or lignitic, together with closely associated substances which include, but are not limited to other hydrocarbon substances physically contained within the same geologic strata as the coal. In the event that minerals other than coal are discovered during lease operations, Lessee shall promptly notify the Lessor.

1.2 Coalbed Methane. To the extent that Lessor owns gas, coalbed methane or coal seam gas (collectively "coalbed methane") within the Leased Premises, Lessee may remove, vent, flare or capture such coalbed methane from the coal strata being mined and any overlying formations if such removal is necessary for safety reasons in the reasonable discretion of Lessee. If Lessee captures or uses such coalbed methane, it shall pay Lessor royalties on the value of such coalbed methane at the prevailing state royalty rate for natural gas, unless such royalties are expressly waived by Lessor. In the event that Lessor does not own coalbed methane within the Leased Premises, Lessee must obtain the consent of the owner of such coalbed methane prior to removal or capture of such gas. Except as expressly granted herein, the right to extract gas, coalbed methane and coal seam gas is not granted by this Lease.

1.3 No Warranty of Title. Lessor claims title to the mineral estate covered by this Lease. Lessor does not warrant title nor represent that no one will dispute the title asserted by Lessor. It is expressly agreed that Lessor shall not be liable to Lessee for any alleged deficiency in title to the mineral estate, nor shall Lessee become entitled to any refund for any rentals, bonuses, or royalties paid under this Lease in the event of title failure.

1.4 Reversion of Leased Premises to United States. Pursuant to the May 8, 1998 "Agreement to Exchange Utah School Trust Lands Between the State of Utah and the United States of America", as ratified by Pub. L. No. 105-335, 112 Stat. 3139, ownership of the Leased Premises shall revert to the United States when SITLA has received $26,102,210 in rental and royalty income plus accrued interest, calculated pursuant to Section I.D.4 of that certain Memorandum of Understanding dated January 5, 1999 between the Utah School & Institutional Trust Lands

Administration, the U.S. Department of the Interior, and the USDA-Forest Service. Upon reversion the United States shall succeed the State of Utah as Lessor.

2. RESERVATIONS TO LESSOR. Subject to the exclusive rights and privileges granted to Lessee under this Lease, and further provided that Lessor shall refrain from taking actions with respect to the Leased Premises that may unreasonably interfere with Lessee's operations, Lessor hereby excepts and reserves from the operation of this Lease the following rights and privileges (to the extent that Lessor has the right to grant such rights and privileges):

2.1 Rights-of-Way and Easements. Lessor reserves the right, following consultation with the Lessee, to establish rights-of-way and easements upon, through or over the Leased Premises, under terms and conditions that will not unreasonably interfere with operations under this Lease, for roads, pipelines, electric transmission lines, transportation and utility corridors, mineral access, and any other purpose deemed reasonably necessary by Lessor.

2.2 Other Mineral Leases. Lessor reserves the right to enter into mineral leases and agreements with third parties covering minerals other than coal, under terms and conditions that will not unreasonably interfere with operations under this Lease in accordance with Lessor's regulations, if any, governing multiple mineral development.

2.3 Use and Disposal of Surface. To the extent that Lessor owns the surface estate of the Leased Premises and subject to the rights granted to the Lessee pursuant to this Lease, Lessor reserves the right to use, lease, sell, or otherwise dispose of the surface estate or any part thereof. Lessor shall notify Lessee of any such sale, lease, or other disposition of the surface estate.

2.4 Previously Authorized Improvements. If authorized improvements have been placed upon the Leased Premises by a third party prior to the commencement of this Lease, Lessee shall allow the owner of such improvements to remove them within ninety (90) days after the Lease term commences. Nothing in this paragraph shall authorize Lessee to remove surface improvements where Lessor does not own the surface estate.

2.5 Rights Not Expressly Granted. Lessor further reserves all rights and privileges of every kind and nature, except as specifically granted in this Lease.

3. TERM OF LEASE; READJUSTMENT.

3.1 Primary Term. This Lease is granted for a "primary term" of ten (10) years commencing on the Effective Date and for a "secondary term" of an additional ten (10) years, subject to Lessee's compliance with the requirements of paragraph 3.3, Diligent Operations; Minimum Royalty.

3.2 Extension Beyond Secondary Term. Subject to Lessee's compliance with the other provisions of this Lease, this Lease shall remain in effect beyond the secondary term and for as long thereafter as coal is produced in commercial quantities from the Leased Premises, or from lands constituting either (i) a logical mining unit approved by the Bureau of Land Management containing the Leased Premises, or (ii) a mining unit, in which the recoverable coal reserves can be developed in an efficient, economical and orderly manner as a unit with due regard to the conservation of recoverable coal reserves. The second type of mining unit requires a determination by the Lessor that the criteria set forth in item (ii) have been satisfied. The satisfaction of either (i) or (ii) above shall mean that the Lease is contained within an "approved mining unit". For the purposes of this Lease, production of coal in commercial quantities shall mean production during each lease year of at least one per cent (1%) of the recoverable coal reserves within the Leased Premises or within lands constituting an approved mining unit which includes the Leased Premises, as such recoverable coal reserves are determined by Lessor after consultation with Lessee, subject to adjustment from time to time based upon reasonable justification from the Lessee.

3.3 Diligent Operations; Minimum Royalty. In the absence of actual production in commercial quantities as set forth in paragraph 3.2, Extension Beyond Secondary Term, this Lease shall remain in effect beyond the primary term only if the Lessee is engaged in diligent operations, exploration, research, or development activity (which development activity shall include, but not be limited to, pursuit of required permits and approvals) which in Lessor's reasonable discretion is calculated to advance development or production of coal from the Leased Premises or lands constituting an approved mining unit which includes the Leased Premises, and Lessee pays an annual minimum royalty in advance on or before the anniversary date of the Effective Date. The minimum royalty shall be calculated by determining the production royalty that would be payable upon production of one per cent (1%) of the recoverable coal reserves within the Leased Premises, as such recoverable coal reserves are determined by Lessor after consultation with Lessee, subject to adjustment from time to time based upon reasonable justification from the Lessee. The unit value of the recoverable coal reserves for purposes of determining the minimum royalty shall be determined by Lessor using the methodology set forth in 43 C.F.R. 3483.4(c)(1)-(3) (1998). Minimum royalties paid by Lessee pursuant to this paragraph may be credited against production royalties accruing during the term of this Lease.

3.4 Expiration; Cessation of Production. This Lease may not be extended pursuant to paragraph 3.3, Diligent Operations; Minimum Royalty, beyond the end of the twentieth year after the Effective Date except by the actual production of coal in commercial quantities from the Leased Premises or from lands constituting an approved mining unit which includes the Leased Premises. After expiration of the secondary term, this Lease will expire of its own terms, without the necessity of any notice or action by Lessor, if Lessee ceases production of coal in commercial quantities for an entire lease year, unless the Lease is suspended pursuant to paragraph 16.3, Suspension.

3.5 Readjustment. At the end of the primary term and at the end of each period of ten (10) years thereafter, Lessor may readjust the terms and conditions of this Lease (including without

limitation rental rates, minimum royalties, royalty rates and valuation methods, and provisions concerning reclamation). In the event that the State as Lessor makes such readjustment prior to reversion, it shall not apply terms and conditions more economically disadvantageous than corresponding federal regulations and lease terms unless, based upon written findings after consultation with Lessee, it determines that the individual term or condition imposing the economic disadvantage is necessary to serve the best interests of the beneficiaries of the subject trust lands. If within thirty (30) days after submission of the readjusted lease terms to the Lessee, the Lessee determines that any or all of the proposed readjusted terms and conditions are unacceptable, then Lessee shall so notify Lessor in writing and the parties shall attempt to resolve the objectionable term or condition. If the parties are unable to resolve the matter and agree upon the readjusted terms and conditions submitted by Lessor at the end of such ten (10) year period, Lessee shall forfeit any right to the continued extension of this lease, and the lease shall automatically terminate, provided that nothing herein shall be deemed to preclude Lessee from appealing any readjustment by Lessor pursuant to applicable law

3.6 Relinquishment. Lessee may relinquish all or portions of this Lease at any time by filing a written notice of relinquishment with Lessor. Lessor may disapprove any relinquishment if Lessee has failed to pay all rentals, royalties, and other amounts due and owing to the Lessor, if the lease is otherwise not in good standing, or if relinquishment would in Lessor's reasonable determination cause waste of economically recoverable coal. Lessee may not relinquish parcels smaller than a quarter-quarter section or surveyed lot. Upon approval, relinquishment shall relieve the Lessee of all future rental obligations as to the relinquished lands effective as of the date of filing of the relinquishment, but shall not relieve Lessee from other obligations to the extent provided in paragraph 15.2, Effect of Termination.

4. BONUS BID. Lessee agrees to pay Lessor, an initial bonus bid in the sum of $21,485,798.50 as partial consideration for Lessor's issuance of this Lease, payable in five equal annual installments of $4,297,159.70. The first annual installment shall be due with Lessee's application to lease and the unpaid balance of the bonus bid shall be paid in equal installments on or before the next four successive anniversaries of the Effective Date of the lease. The bonus bid shall not bear interest; provided, however, that if this Lease is relinquished or otherwise terminated prior to the payment in full of the bonus bid, or if Lessee fails to make any bonus bid payment when due, the entire unpaid balance of the bonus bid shall immediately become due without regard to such relinquishment or termination, and such balance shall thereafter bear interest as provided in paragraph 16.2, Interest. Lessor may require Lessee to submit a bond or other sufficient surety to secure Lessee's obligation to pay the unpaid balance of the bonus bid. The initial bonus bid may not be credited against any other bonus payments, annual rentals or royalties accruing under the lease.

5. RENTALS. Lessee agrees to pay Lessor an annual rental of three dollars ($3.00) for each acre and fractional part thereof within the Leased Premises. Lessee shall promptly pay annual rentals each year in advance on or before the anniversary date of the Effective Date. Lessee may not credit rentals against

production royalties or against minimum royalties payable pursuant to paragraph 3.3, Diligent Operations; Minimum Royalty.

6. ROYALTIES.

6.1 Production Royalties. Lessee shall pay Lessor a production royalty of eight per cent (8%) of the value of all coal severed and removed from the Leased Premises. For all coal sold pursuant to an arm's-length contract, value shall be determined on the basis of the gross proceeds received by Lessee from the sale or disposition of such coal. Gross proceeds shall include all bonuses, allowances or other consideration of any nature received by Lessee for coal actually produced. For any coal that is sold or disposed of other than by an arms-length contract, or for coal that is used within the mine permit area containing the Leased Premises for generation of electricity or for gasification, liquefaction, in situ processing, or other method of extracting energy from such coal, the value of such coal shall be determined by Lessor with reference to (in order of priority): (i) comparable arms-length contracts or other dispositions of like-quality coal produced in the same coal field; (ii) prices reported for that coal to a public utility commission; (iii) prices reported to other governmental agencies; or (iv) other relevant information.

6.2 Allowable Deductions. It is expressly understood and agreed that none of Lessee's mining or production costs, including but not limited to costs for materials, labor, overhead, distribution, transportation within the mine permit area prior to the point of sale, loading, crushing, sizing, screening, or general and administrative activities, may be deducted in computing Lessor's royalty. All such costs shall be entirely borne by Lessee and are anticipated by the rate of royalty set forth in this Lease. In the event that the point of sale for coal produced from this Lease is located outside the mine permit area boundary, Lessee may deduct the reasonable, actual costs of transportation of such coal from the mine permit area boundary to the point of sale from gross proceeds in computing Lessor's royalty; provided, however, that transportation deductions for coal transported by Lessee, Lessee's affiliates, or by non-arm's-length contract are subject to review and modification by Lessor. Lessee shall be allowed to deduct its actual, reasonable washing and treatment costs from gross proceeds in computing Lessor's royalty; provided, however, that, upon Lessor's request Lessee shall provide to Lessor appropriate justification to demonstrate that Lessee's costs are reasonable.

6.3 Reference to Federal Regulations. It is the intent of Lessor and Lessee that the calculation of the value of coal for royalty purposes be consistent with federal coal regulations governing the valuation of coal, except where this Lease expressly provides otherwise. In no event shall the value of coal used for calculation of royalties under this Lease be less than the value which would be obtained were federal royalty valuation regulations applied.

6.4 Royalty Payment. For all coal severed and removed from the Leased Premises that is used, sold, transported or otherwise disposed of during a particular month, Lessee shall pay royalties to

Lessor on or before the end of the next succeeding month. Royalty payments shall be accompanied by a verified statement, in a form approved by Lessor, stating the amount of coal sold or otherwise disposed of, the gross proceeds accruing to Lessee, the calculation of allowable deductions, and any other information reasonably required by Lessor to verify production and disposition of the coal or coal products. In the event that Lessee uses or disposes of coal pursuant to a non-arm's-length contract, or uses coal for generation of electricity or for gasification, liquefaction, in situ processing, or other method of extracting energy from such coal, Lessee shall notify Lessor of such use or disposal on or before the end of the next succeeding month following such use or disposal, and shall pay royalties upon Lessee's good faith estimate of the value of such coal, subject to Lessor's right to determine the value of such coal pursuant to paragraph 6.1, Production Royalties. After reversion of the Leased Premises to the United States pursuant to paragraph 1.4, Reversion of Leased Premises to United States, Lessee shall report production and royalties monthly in accordance with applicable federal regulations.

6.5 Royalty Valuation After Reversion. After reversion of the Leased Premises to the United States pursuant to paragraph 1.4, Reversion of the Leased Premises to the United States, the Secretary of the Interior may establish the reasonable value of post-reversion production for royalty purposes in the same manner and by the same methods as the United States establishes value under coal leases issued by the United States.

6.6 Suspension, Waiver or Reduction of Rents or Royalties. Lessor, to the extent not prohibited by applicable law, is authorized to waive, suspend, or reduce the rental or minimum royalty, or reduce the royalty applicable with respect to the entire Lease, whenever in Lessor's judgment it is necessary to do so in order to promote development, or whenever in the Lessor's judgment the Lease cannot be successfully operated under the terms provided herein.

7. RECORDKEEPING; INSPECTION; AUDITS.

7.1 Registered Agent; Records. Lessee shall maintain a registered agent within the State of Utah to whom any and all notices may be sent by Lessor and upon whom process may be served. Lessee shall also maintain an office within the State of Utah containing originals or copies of all maps, engineering data, permitting materials, books, records or contracts (whether such documents are in paper or electronic form) generated by Lessee that pertain in any way to coal production, output and valuation; mine operations; coal sales and dispositions; transportation costs; and calculation of royalties from the Leased Premises. Lessee shall maintain such documents for at least seven years after the date of the coal production to which the documents pertain.

7.2 Inspection. Lessor's employees and authorized agents at Lessor's sole risk and expense shall have the right to enter the Leased Premises to check scales as to their accuracy, and to go on any part of the Leased Premises to examine, inspect, survey and take measurements for the purposes of verifying production amounts and proper lease operations. Upon reasonable notice to Lessee,

Lessor's employees and authorized agents shall further have the right to audit, examine and copy (at Lessor's expense) all documents described in paragraph 7.1, Registered Agent; Records, whether such documents are located at the mine site or elsewhere. Lessee shall furnish all conveniences necessary for said inspection, survey, or examination; provided, however, that such inspections shall be conducted in a manner that is in conformance with all applicable mine safety regulations and does not unreasonably interfere with Lessee's operations.

7.3 Federal Inspections. Lessee agrees that, prior to reversion of the Leased Premises to the United States, employees and authorized agents of the Bureau of Land Management ("BLM") may conduct underground inspections of the Leased Premises, both independently and in cooperation with the State in its capacity as Lessor. After reversion, employees and authorized agents of BLM may conduct underground inspections of the Leased Premises under the authority of applicable federal laws and regulations.

7.4 Geologic Information. In the event Lessee conducts core-drilling operations or other geologic evaluation of the Leased Premises, Lessor may inspect core samples, evaluations thereof, and proprietary geologic information concerning the Leased Premises.

7.5 Confidentiality. Any and all documents and geologic data obtained by Lessor through the exercise of its rights as set forth in paragraphs 7.2, Inspection., and 7.4, Geologic Information., may be declared confidential information by Lessee, in which event Lessor and its authorized agents shall maintain such documents and geologic data as protected records under the Utah Governmental Records Access Management Act or other applicable privacy statute (including applicable federal law after reversion), and shall not disclose the same to any third party without the written consent of Lessee, the order of a court of competent jurisdiction requiring such disclosure, or upon termination of this Lease. Following reversion of the Leased Premises to the United States, the United States as Lessor shall treat such information as confidential to the extent permitted by federal law.

8. USE OF SURFACE ESTATE.

8.1 Lessor-Owned Surface. If Lessor owns the surface estate of all or some portion of the Leased Premises, by issuance of this Lease the Lessee has been granted the right to make use of such lands to the extent reasonably necessary and expedient for the economic operation of the leasehold. Lessee's right to surface use of Lessor-owned surface estate shall include the right to subside the surface. Such surface uses shall be exercised subject to the rights reserved to Lessor as provided in paragraph 2, RESERVATIONS TO LESSOR, and without unreasonable interference with the rights of any prior or subsequent lessee of Lessor.

8.2 Split-Estate Lands. If Lessor does not own the surface estate of any portion of the Leased Premises, Lessee's access to and use of the surface of such lands shall be determined by

applicable law governing mineral development on split-estate lands, including without limitation applicable statutes governing access by mineral owners to split estate lands, and reclamation and bonding requirements. Lessee shall indemnify, defend and hold Lessor harmless for all claims, causes of action, damages, costs and expenses (including attorney's fees and costs) arising out of or related to damage caused by Lessee's operations to surface lands or improvements owned by third parties.

9. APPLICABLE LAWS AND REGULATIONS; HAZARDOUS SUBSTANCES

9.1 Trust Lands Statute and Regulations. This Lease is issued pursuant to the provisions of Title 53C, Utah Code Annotated, 1953, as amended, and Lessee is subject to and shall comply with all current and future rules and regulations adopted by the School and Institutional Trust Lands Administration and its successor agencies until reversion of the Leased Premises to the United States pursuant to paragraph 1.4, Reversion of Leased Premises to United States.

9.2 Regulation Upon Reversion. After reversion of the Leased Premises to the United States pursuant to paragraph 1.4, Reversion of Leased Premises to United States, Lessee will be subject to the requirements of the Mineral Leasing Act, 30 U.S.C. 181 *et seq.* (the "MLA"), and to the royalty, operating, and administrative procedure rules and regulations of the Department of Interior, the Minerals Management Service, and the Bureau of Land Management, and to any other federal laws and regulations generally applicable to coal leases issued under the MLA to the same extent as if the Lease were a federally-issued lease. Notwithstanding the foregoing, to the extent that the State, as Lessor, approves a significant operational decision prior to reversion, and Lessee makes a substantial economic commitment based upon that approval, Lessee may continue to rely upon that approval after reversion; provided, however, that no such approval shall act to limit the liability of Lessee, if any, under CERCLA, RCRA, the Clean Water Act, 33 U.S.C. 1251 *et seq* or other applicable environmental law. Upon reversion, nothing in this paragraph shall be deemed to require that the Leased Premises be included in the calculation of acreage held by Lessee for the purposes of the acreage limitation provisions of the MLA and associated regulations.

9.3 Other Applicable Laws and Regulations. Lessee shall comply with all applicable federal, state and local statutes, regulations, and ordinances, including without limitation the Utah Coal Mining and Reclamation Act, applicable statutes and regulations relating to mine safety and health, and applicable statutes, regulations and ordinances relating to public health, pollution control, management of hazardous substances and environmental protection.

9.4 Hazardous Substances. Lessee [or other occupant pursuant to any agreement authorizing mining] shall not keep on or about the premises any hazardous substances, as defined under 42 U.S.C. 9601(14) or any other Federal environmental law, any regulated substance contained in or released from any underground storage tank, as defined by the Resource Conservation and Recovery Act, 42 U.S.C. 6991, *et seq*, or any substances defined and regulated as "hazardous" by

applicable State law, (hereinafter, for the purposes of this Lease, collectively referred to as "Hazardous Substances") unless such substances are reasonably necessary in Lessee's mining operations, and the use of such substances or tanks is noted and approved in the Lessee's mining plan, and unless Lessee fully complies with all Federal, State and local laws, regulations, statutes, and ordinances, now in existence or as subsequently enacted or amended, governing Hazardous Substances. Lessee shall immediately notify Lessor, the Bureau of Land Management, the surface management agency, and any other Federal, State and local agency with jurisdiction over the Leased Premises, or contamination thereon, of (i) all reportable spills or releases of any Hazardous Substance affecting the Leased Premises, (ii) all failures to comply with any applicable Federal, state or local law, regulation or ordinance governing Hazardous Substances, as now enacted or as subsequently enacted or amended, (iii) all inspections of the Leased Premises by, or any correspondence, order, citations, or notifications from any regulatory entity concerning Hazardous Substances affecting the Leased Premises, (iv) all regulatory orders or fines or all response or interim cleanup actions taken by or proposed to be taken by any government entity or private Party concerning the Leased Premises.

9.5 Hazardous Substances Indemnity. Lessee [or other occupant pursuant to any agreement authorizing mining] shall indemnify, defend, and hold harmless Lessor and the United States (as successor Lessor or owner pursuant to reversion or as owner of surface estate) its agencies, employees, officers, and agents with respect to any and all damages, costs, liabilities, fees (including attorneys' fees and costs), penalties (civil and criminal), and cleanup costs arising out of or in any way related to Lessee's use, disposal, transportation, generation, sale or location upon or affecting the Leased Premises of Hazardous Substances, as defined in paragraph 9.4 of this Lease. This indemnity shall extend to the actions of Lessee's employees, agents assigns, sublessees, contractors, subcontractors, licensees and invitees. Lessee shall further indemnify, defend and hold harmless Lessor and the United States from any and all damages, costs, liabilities, fees (including attorneys' fees and costs), penalties (civil and criminal), and cleanup costs arising out of or in any way related to any breach of the provisions of this Lease concerning Hazardous Substances. This indemnity is in addition to, and in no way limits, the general indemnity contained in paragraph 16.1 of this Lease.

9.6 Waste Certification. The Lessee shall provide upon abandonment, transfer of operation, assignment of rights, sealing-off of a mined area, and prior to lease relinquishment, certification to the Lessor and the Bureau of Land Management that, based upon a complete search of all the operator's records for the Lease, and upon its knowledge of past operations, there have been no reportable quantities of hazardous substances as defined in 40 C.F.R. 302.4, or used oil as defined in Utah Administrative Code R315-15, discharged (as defined at 33 U.S.C. 1321(a)(2)), deposited or released within the Leased Premises, either on the surface or underground, and that all remedial actions necessary have been taken to protect human health and the environment with respect to such substances. Lessee shall additionally provide to Lessor and the Bureau of Land Management a complete list of all hazardous substances, hazardous materials, and their respective Chemical

Abstracts Service Registry Numbers, and oil and petroleum products used or stored on, or delivered to, the Leased Premises. Such disclosure will be in addition to any other disclosure required by law or agreement.

10. BONDING.

10.1 Lease Bond Required. At the time this lease is executed, Lessee shall execute and file with the Lessor a good and sufficient bond or other financial guarantee acceptable to Lessor in order to: (a) guarantee Lessee's performance of all covenants and obligations under this Lease, including Lessee's obligation to pay royalties; and (b) ensure compensation for damage, if any, to the surface estate and any surface improvements. The Lease Bond shall meet all federal mineral lease bond requirements as described in 43 C.F.R. Subpart 3474. The Lease Bond shall further provide that upon forfeiture after reversion of the Leased Premises to the United States, the Lease Bond shall be payable to the Secretary of the Interior.

10.2 Reclamation Bonding. The bond filed with the Utah Division of Oil, Gas and Mining ("UDOGM") in connection with the issuance of a mine permit which includes the Leased Premises shall be deemed to satisfy Lessor's bonding requirements with respect to Lessee's reclamation obligations under this Lease; provided, however, upon notice to Lessee and a public hearing with respect to the basis for its decision, the Lessor may, in its reasonable discretion, determine that the bond filed with UDOGM is insufficient to protect Lessor's interests. In such an event the Lessor shall enter written findings as to the basis for its calculation of the perceived insufficiency and enter an order establishing the amount of additional bonding required. Lessee shall file any required additional bond with Lessor within thirty (30) days after demand by Lessor. Lessor may increase or decrease the amount of any additional bond from time to time in accordance with the same procedure. Lessee may combine any additional bond required under this paragraph with the original lease bond filed under Paragraph 10.1, Lease Bond Required.

10.3 Release of Additional Bond. Any additional bond required by Lessor pursuant to Paragraph 10.2, Reclamation Bonding, may be released by Lessor at any time and shall be released no later than the time of final bond release by UDOGM with respect to the Leased Premises.

11. WATER RIGHTS.

11.1 Water Rights in Name of Lessor. If Lessee files to appropriate water for coal mining operations on the Leased Premises, the filing for such water right shall be made by Lessee in the name of Lessor at no cost to Lessor, and such water right shall become an appurtenance to the Leased Premises, subject to Lessee's right to use such water right at no cost during the term of this Lease.

11.2 Option to Purchase. If Lessee purchases or acquires an existing water right for coal mining operations on the Leased Premises, Lessor shall have the option to acquire that portion of such water right as was used on the Leased Premises upon expiration or termination of this Lease. The option price for such water right shall be the fair market value of the water right as of the date of expiration or termination of this Lease. Upon expiration or termination of this Lease, Lessee shall notify Lessor in writing of all water rights purchased or acquired by Lessee for coal mining operations on the Leased Premises and its estimate of the fair market value of such water right. Lessor shall then have forty-five (45) days to exercise its option to acquire the water by payment to Lessee of the estimated fair market value. If Lessor disagrees with Lessee' s estimate of fair market value, Lessor shall notify Lessee of its disagreement within the 45 day option exercise period. The fair market value of the water right shall then be appraised by a single appraiser mutually acceptable to both parties, which appraisal shall be final and not subject to review or appeal. If the parties cannot agree upon the choice of an appraiser, the fair market value of the water right shall be determined by a court of competent jurisdiction. Conveyance of any water right pursuant to this paragraph shall be by quit claim deed.

11.3 Reversion. Upon reversion of the Leased Premises to the United States, the United States shall succeed to the interests of the State of Utah pursuant to this article 11.

12. ASSIGNMENT OR SUBLEASE; OVERRIDING ROYALTIES.

12.1 Consent Required. Lessee shall not assign or sublease this Lease in whole or in part, or otherwise assign or convey any rights or privileges granted by this Lease, including, without limitation, creation of overriding royalties or production payments, without the prior written consent of Lessor. Any assignment, sublease or other conveyance made without prior written consent of Lessor shall have no legal effect unless and until approved in writing by Lessor. Exercise of any right with respect to the Leased Premises in violation of this provision shall constitute a default under this Lease.

12.2 Binding Effect. All of the terms and provisions of this Lease shall be binding upon and shall inure to the benefit of their respective successors, assigns, and sublessees.

12.3 Limitation on Overriding Royalties. Lessor reserves the right to disapprove the creation of an overriding royalty or production payment that would, in Lessor' s reasonable discretion, constitute an unreasonable economic burden upon operation of the Lease. In exercising its discretion to disapprove the creation of an overriding royalty, Lessor shall consult with Lessee and any third parties involved and shall prepare findings to evidence the basis of its decision. Cumulative overriding royalties of 2% or less shall be deemed presumptively reasonable unless special circumstances are shown by Lessor to exist.

13. OPERATIONS.

13.1 Permitting. Before Lessee commences exploration, drilling, or mining operations on the Leased Premises, it shall have obtained such permits and posted such bonds as may be required under applicable provisions of the Utah Coal Mining and Reclamation Act, the Surface Mining Control and Reclamation Act, and associated regulations, together with applicable regulations of the surface management agency. Lessee shall maintain any required permits in place for the duration of mining operations and reclamation. Upon request, Lessee shall provide Lessor with a copy of all regulatory filings relating to permitting matters.

13.2 Plan of Operations. Prior to the commencement of any underground mining operations on the Leased Premises, Lessee shall obtain Lessor's approval of a plan of operations for the Leased Premises. The plan of operations shall contain all information required to be contained in a federal Resource Recovery and Protection Plan, as described in 43 C.F.R. • 3482.1(b) and (c) (1998). Lessor may modify the proposed plan of operations as is needed to insure that there is no waste of economically recoverable coal reserves contained on the Leased Premises. In this context "waste" shall mean the inefficient utilization of, or the excessive or improper loss of an otherwise economically recoverable coal resource. Lessor shall notify Lessee in writing of its approval or modifications of the plan of operations. The plan of operations submitted by Lessee shall be deemed approved by Lessor if Lessor has not otherwise notified Lessee within sixty (60) days of filing.

13.3 Plan of Operations - Modification. In the event that material changes are required to the plan of operations during the course of mining, Lessee shall submit a modification of the plan of operations to the Lessor. Routine adjustments to the plan of operations based upon geologic circumstances encountered during day-to-day mining operations do not require the submission of a modification. If the proposed changes require emergency action by Lessor, then the Lessee shall so notify the Lessor at the time of submission of the modification and the parties shall use their best efforts to meet the Lessee's time schedule regarding implementation of the changes. Non-emergency modifications will be reviewed promptly by Lessor to insure that there is no waste of economically recoverable coal reserves pursuant to the plan of operations, as modified, and Lessor shall notify lessee in writing of its approval or modification of the proposed modification. Prior to reversion, modifications shall be deemed approved by Lessor if Lessor has not otherwise notified Lessee within thirty (30) days of filing. After reversion, modifications shall be approved in accordance with applicable federal regulations.

13.4 Mine Maps. Lessee shall maintain at the mine office clear, accurate, and detailed maps of all actual and planned operations prepared and maintained in the manner prescribed by 43 C.F.R. 3482.3 (1998). Lessee shall provide copies of such maps to Lessor upon request.

13.5 Good Mining Practices. Lessee shall conduct exploration and mining operations on the Leased Premises in accordance with standard industry operating practices, and shall avoid waste of

economically recoverable coal. Lessee shall comply with all regulations and directives of the Mine Safety and Health Administration or successor agencies for the health and safety of employees and workers. Lessee shall further comply with the performance standards for underground resource recovery set forth at 43 C.F.R. 3484.1(c) (1998); provided, however, that Lessor may waive such standards from time to time in its reasonable discretion, upon request by Lessee. Coal shall be mined from this Lease by underground methods only.

13.6 Mining Units. Lessor may approve the inclusion of the Leased Premises in a mining unit with federal, private or other non-state lands upon terms and conditions that it deems necessary to protect the interests of the Lessor, including without limitation segregation of production, accounting for commingled coal production, and minimum production requirements or minimum royalties for the Leased Premises.

14. EQUIPMENT; RESTORATION.

14.1 Equipment. Upon termination of this Lease, Lessee shall remove, and shall have the right to remove, all improvements, equipment, stockpiles, and dumps from the Leased Premises within six (6) months; provided, however, that Lessor may, at Lessor's sole risk and expense, and subject to Lessee's compliance with requirements imposed by UDOGM and MSHA, require Lessee to retain in place underground timbering supports, shaft linings, rails, and other installations reasonably necessary for future mining of the Leased Premises. All improvements and equipment remaining on the Leased Premises after six (6) months may be deemed forfeited to Lessor upon written notice of such forfeiture to Lessee. Lessee may abandon underground improvements, equipment of any type, stockpiles and dumps in place if such abandonment is in compliance with applicable law, and further provided that Lessee provides Lessor with financial or other assurances sufficient in Lessor's reasonable discretion to protect Lessor from future environmental liability with respect to such abandonment or any associated hazardous waste spills or releases. Lessee shall identify and locate on the mine map the location of all equipment abandoned on the Lease Premises.

14.2 Restoration and Reclamation. Upon termination of this Lease, Lessee shall reclaim the Leased Premises in accordance with the requirements of applicable law, including mine permits and reclamation plans on file with UDOGM. Lessee shall further abate any hazardous condition on or associated with the Leased Premises. Lessee and representatives of all governmental agencies having jurisdiction shall have the right to re-enter the Leased Premises for reclamation purposes for a reasonable period after termination of the Lease.

15. DEFAULT

15.1 Notice of Default; Termination. Upon Lessee's violation of or failure to comply with any of the terms, conditions or covenants set forth in this Lease, Lessor shall notify Lessee of such default by

registered or certified mail, return receipt requested, at the last address for Lessee set forth in Lessor's files. Lessee shall then have thirty (30) days, or such longer period as may be granted in writing by Lessor, to either cure the default or request a hearing pursuant to the Lessor's administrative adjudication rules. In the event Lessee fails to cure the default or request a hearing within the specified time period, Lessor may cancel this Lease without further notice to or appeal by Lessee.

15.2 Effect of Termination. The termination of this Lease for any reason, whether through expiration, cancellation or relinquishment, shall not limit the rights of the Lessor to recover any royalties and/or damages for which Lessee may be liable, to recover on any bond on file, or to seek injunctive relief to enjoin continuing violations of the Lease terms. No remedy or election under this Lease shall be deemed exclusive, but shall, wherever possible, be cumulative with all other remedies available under this Lease, at law, or in equity. Lessee shall surrender the Leased Premises upon termination; however, the obligations of Lessee with respect to reclamation, indemnification and other continuing covenants imposed by this Lease shall survive the termination.

16. MISCELLANEOUS PROVISIONS.

16.1 Indemnity. Except as limited by paragraph 7.2, Inspection, Lessee shall indemnify and hold Lessor and the United States (as successor Lessor or owner pursuant to reversion or as owner of surface estate) harmless for, from and against each and every claim, demand, liability, loss, cost, damage and expense, including, without limitation, attorneys' fees and court costs, arising in any way out of Lessee's occupation and use of the Leased Premises, including without limitation claims for death, personal injury, property damage, and unpaid wages and benefits. Lessee further agrees to indemnify and hold Lessor harmless for, from and against all claims, demands, liabilities, damages and penalties arising out of any failure of Lessee to comply with any of Lessee's obligations under this Lease, including without limitation attorneys' fees and court costs.

16.2 Interest. Except as set forth in paragraph 4, BONUS BID, interest shall accrue and be payable on all obligations arising under this Lease at such rate as may be set from time to time by rule enacted by Lessor. Interest shall accrue and be payable, without necessity of demand, from the date each such obligation shall arise.

16.3 Suspension. In the event that Lessor in its reasonable discretion determines that suspension is necessary in the interests of conservation of the coal resource, or if Lessee has been prevented from performing any of its obligations or responsibilities under this Lease or from conducting mining operations by labor strikes, fires, floods, explosions, riots, any unusual mining casualties or conditions, Acts of God, government restrictions or orders, severe weather conditions, or other extraordinary events beyond its control, then the time for performance of this Lease by Lessee

shall be suspended during the continuance of such acts which prevent performance, excepting any payments due and owing to Lessor.

16.4 Consent to Suit; Jurisdiction. Prior to reversion of the Leased Premises to the United States: (i) this Lease shall be governed by the laws of the State of Utah; (ii) Lessor and Lessee agree that all disputes arising out of this Lease shall be litigated only in the Third Judicial District Court for Salt Lake County, Utah; (iii) Lessee consents to the jurisdiction of such court; and (iv) Lessee shall not bring any action against Lessor without exhaustion of available administrative remedies and compliance with applicable requirements of the Utah Governmental Immunity Act. Notwithstanding the foregoing, after reversion of the Leased Premises to the United States, any litigation between the United States as Lessor and the Lessee shall be governed by the laws of the United States otherwise applicable to federal coal leases.

16.5 No Waiver. No waiver of the breach of any provision of this Lease shall be construed as a waiver of any preceding or succeeding breach of the same or any other provision of this Lease, nor shall the acceptance of rentals or royalties by Lessor during any period of time in which Lessee is in default be deemed to be a waiver of such default.

16.6 Severability. The invalidity of any provision of this Lease, as determined by a court of competent jurisdiction, shall in no way affect the validity of any other provision hereof.

16.7 Entire Lease. This Lease, together with any attached stipulations, sets forth the entire agreement between Lessor and Lessee with respect to the subject matter of this Lease. No subsequent alteration or amendment to this Lease shall be binding upon Lessor and Lessee unless in writing and signed by each of them.

IN WITNESS WHEREOF, the parties have executed this Lease as of the date hereinabove first written.

APPROVED AS TO FORM:
MARK L. SHURTLEFF
ATTORNEY GENERAL

By: _____

Date: 1/8/08

THE STATE OF UTAH, acting by and through the SCHOOL AND INSTITUTIONAL TRUST LANDS ADMINISTRATION ("LESSOR")

THOMAS B. FADDIES
DIRECTOR/MINERALS

School & Institutional Trust Lands Administration - LESSOR

ARK LAND COMPANY ("LESSEE")

By: _____

Its: _____

STATE OF UTAH )
: ss.
COUNTY OF SALT LAKE )

On the 18 day of January, 2008, personally appeared before me Thomas B Faddis who being by me duly sworn did say that he is Assistant Director of the School and Institutional Trust Lands Administration of the State of Utah and the signer of the above instrument, who duly acknowledged that he executed the same.

Given under my hand and seal this 18th day of January 2008.

Alice K Kearney
Notary Public
Residing at:

My commission expires: 5/25/2010

NOTARY PUBLIC
ALICE K. KEARNEY
675 E 500 S. Suite 500
Salt Lake City, Utah 84102
My Commission Expires
May 25, 2010
STATE OF UTAH

STATE OF ~~UTAH~~ Missouri )
St. Louis : ss.
COUNTY OF ~~SALT LAKE~~ )

On the 21st day of January, 2008, personally appeared before me Steven E. McCardy, who being duly sworn did say that he is an officer of Ark Land Company and that said instrument was signed in behalf of said corporation by resolution of its Board of Directors, and said that he acknowledged to me that said corporation executed the same.

Given under my hand and seal this 21st day of January, 2008.

Carla A Veizer
Notary Public
Residing at:

My commission expires: 10/28/2010

CARLA A. VEIZER
St. Louis County
NOTARY PUBLIC
Comm # 06427065
NOTARY SEAL
My Commission Expires 10-28-2010
STATE OF MISSOURI

## SPECIAL STIPULATIONS

**Forest Service Stipulation #1**

Before undertaking activities that may disturb the surface of previously undisturbed leased lands, the Lessee may be required to conduct a cultural resource inventory and a paleontological appraisal of the areas to be disturbed. These studies shall be conducted by qualified professional cultural resource specialists or qualified paleontologists, as appropriate, and a report prepared itemizing the findings. A plan will then be submitted making recommendations for the protection of, or measures to be taken to mitigate impacts for identified cultural or paleontological resources.

If cultural resources or paleontological remains (fossils) of significant scientific interest are discovered during operations under this lease, the Lessee prior to disturbance shall immediately bring them to the attention of the appropriate authority. Paleontological remains of significant scientific interest do not include leaves, ferns or dinosaur tracks commonly encountered during underground mining operations.

The cost of conducting the inventory, preparing reports, and carrying out mitigating measures shall be borne by the Lessee.

**Forest Service Stipulation #2**

If there is reason to believe that Threatened or Endangered (T&E) species of plants or animals, or migratory bird species of high Federal interest occur in the area, the Lessee shall be required to conduct an intensive field inventory of the area to be disturbed and/or impacted. The inventory shall be conducted by a qualified specialist and a report of findings will be prepared. A plan will be prepared making recommendations for the protection of these species or action necessary to mitigate the disturbance.

The cost of conducting the inventory, preparing reports and carrying out mitigating measures shall be borne by the Lessee.

**Forest Service Stipulation #3**

The Lessee shall be required to perform a study to secure adequate baseline data to quantify the existing surface resources on and adjacent to the lease area. Existing data may be used if such data are adequate for the intended purposes. The study shall be adequate to locate, quantify, and demonstrate the interrelationship of the geology, topography, surface and ground water hydrology, vegetation and wildlife. Baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison.

**Forest Service Stipulation #4**

Powerlines used in conjunction with the mining of coal from this lease shall be constructed so as to provide adequate protection for raptors and other large birds. When feasible, powerlines will be located at least 100

yards from public roads.

**Forest Service Stipulation #5**

The limited area available for mine facilities at the coal outcrop, steep topography, adverse winter weather, and physical limitations on the size and design of access roads, are factors which will determine the ultimate size of the surface area utilized for the mine. A site-specific environmental analysis will be prepared for each new mine site development and for major improvements to existing developments to examine alternatives and mitigate conflicts.

**Forest Service Stipulation #6**

Consideration will be given to site selection to reduce adverse visual impacts. Where alternative sites are available, and each alternative is technically feasible, the alternative involving the least damage to the scenery and other resources shall be selected. Permanent structures and facilities will be designed, and screening techniques employed to reduce visual impacts and, where possible, achieve a final landscape compatible with the natural surroundings. The creation of unusual, objectionable, or unnatural landforms and vegetative landscape features will be avoided.

**Forest Service Stipulation #7**

The Lessee shall be required to establish a monitoring system to locate, measure and quantify the progressive and final effects of underground mining activities on the topographic surface, underground and surface hydrology and vegetation. The monitoring system shall utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the lease area. The monitoring shall incorporate and be an extension of the baseline data.

**Forest Service Stipulation #8**

The Lessee shall provide for the suppression and control of fugitive dust on haul roads and at coal handling and storage facilities. On Forest Development Roads (FDR), Lessees may perform their share of road maintenance by a commensurate share agreement if a significant degree of traffic is generated that is not related to their activities.

**Forest Service Stipulation #9**

Except at locations specifically approved by the Authorized Officer with concurrence of the Surface Management Agency, underground mining operations shall be conducted in such a manner so as to prevent surface subsidence that would: (1) cause the creation of hazardous conditions such as potential escarpment failure and landslides, (2) cause damage to existing surface structures, and (3) damage or alter the flow of perennial streams. The Lessee shall provide specific measures for the protection of escarpments, and determine corrective measures to assure that hazardous conditions are not created.

**Forest Service Stipulation #10**

In order to avoid surface disturbance on steep canyon slopes and to preclude the need for surface access, all surface breakouts for ventilation tunnels shall be constructed from inside the mine, except at specific approved locations.

**Forest Service Stipulation #11**

If removal of timber is required for clearing of construction sites, etc., such timber shall be removed in accordance with the regulations of the surface management agency.

**Forest Service Stipulation #12**

The coal contained within, and authorized for mining under this lease shall be extracted only by underground mining methods.

**Forest Service Stipulation #13**

Existing Forest Service owned or permitted surface improvements shall be protected by the Lessee during coal mining operations. Any such improvements damaged or destroyed by such coal mining operations shall be restored or replaced by the Lessee as directed by the Forest Service.

**Forest Service Stipulation #14**

In order to protect big-game wintering areas, elk calving and deer fawning areas, sagegrouse strutting areas, and other key wildlife habitat and/or activities, specific surface uses outside the mine development area may be curtailed during specified periods of the year.

**Forest Service Stipulation #15**

Support facilities, structures, equipment, and similar developments will be removed from the lease area within two years after the final termination of use of such facilities. This provision shall apply unless the requirement of Section 10 of the lease form is applicable. Disturbed areas and those areas previously occupied by such facilities will be stabilized and rehabilitated, drainages re-established, and the areas returned to a premining land use.

**Forest Service Stipulation #16**

The Lessee, at the conclusion of the mining operation, or at other times as surface disturbance related to mining may occur, will replace all damaged, disturbed or displaced corner monuments (section corners, 1/4 corners, etc.), their accessories and appendages (witness trees, bearing trees, etc.), or restore them to their original condition and location, or at other locations that meet the requirements of the rectangular surveying system. This work shall be conducted at the expense of the Lessee, by a professional land surveyor registered in the State of Utah, and to the standards and guidelines found in the Manual of Surveying Instructions, United States Department of the Interior.

**Forest Service Stipulation #17**

The Lessee, at its expense, will be responsible to replace any surface and/or developed groundwater sources identified for protection, that may be lost or adversely affected by mining operations, with water from an alternate source in sufficient quantity and quality to maintain existing riparian habitat, fishery habitat, livestock and wildlife use, or other land uses.

**Forest Service Stipulation #18**

The Lessee must comply with all the rules and regulations of the Secretary of Agriculture set forth at Title 36, Chapter II, of the Code of Federal Regulations governing the use and management of the National Forest System (NFS) when not inconsistent with: (1) the May 8, 1998 "Agreement to Exchange Utah School Trust Lands Between the State of Utah and the United States of America", as ratified by Pub. L. No. 105-335, 112 Stat. 3139 and implemented by that certain Memorandum of Understanding dated January 5, 1999 between the Utah School & Institutional Trust Lands Administration, the U.S. Department of the Interior, and the USDA-Forest Service, as amended; or (2) the rights granted to Lessee under a mine permit issued under the Surface Mining Control and Reclamation Act and/or the Utah Coal Mining and Reclamation Act, and applicable rules and regulations under those statutes. The Secretary of Agriculture's rules and regulations must be complied with for: (1) all use and occupancy of the NFS prior to approval of the mine permit; (2) uses of all existing improvements, such as Forest Development Roads, within and outside the area licensed, permitted or leased; and (3) use and occupancy of the NFS not authorized by the mine permit.

Requests for approval related to this stipulation are to be addressed to:

Forest Supervisor
Manti-La Sal National Forest
599 West Price River Drive
Price, Utah 84501
Telephone Number: 801-637-2817

who is the authorized representative of the Secretary of Agriculture, with a copy to Lessor

**Stipulation #19 Protection of Joes Valley Dam and Reservoir**

The plan of mining operations submitted by Lessee, and any modifications thereof, shall be designed to ensure no adverse impacts of such mining operations upon the nearby Joes Valley Dam and Reservoir and shall describe in detail such measures or precautions as may be taken to protect the dam and reservoir. Any apparent draining of Joes Valley Reservoir as a direct result of mining operations under the lease shall immediately be investigated by the lessee, employing competent geotechnical or hydrological engineers, and mitigated. Lessee's indemnity obligations to Lessor pursuant to Section 16.1 of this Lease shall extend to any claims, demands, liability, loss, cost, damage and expense, including, without limitation, attorneys' fees and court costs, arising in any way out of or related to mining-related impacts on the dam or reservoir. This indemnification obligation is not intended

to create any third-party rights to indemnification in parties other than the State of Utah as Lessor (or the United States as Lessor after reversion.

U.S. Bureau of Reclamation policy requires that whenever Joes Valley Dam experiences mining-induced ground accelerations equal to, or greater than, 0.05 g's, measured at the dam, a detailed inspection of the dam is performed. The inspection will include structural behavior surveys, piezometer readings, and visual inspection in accordance with the dam's Emergency Action Plan. The lessee will reimburse the Bureau of Reclamation and the Emery Water Conservancy District for reasonable out-of-pocket expenses incurred for such inspections when such mining-induced ground acceleration originated within the leased premises.

**Stipulation #20 Commencement of Minimum Annual Royalty**

Notwithstanding any other provisions of this lease, Lessee shall commence paying minimum royalties pursuant to paragraph 3.3 of this lease in the lease year beginning on the fifth anniversary of the Effective Date.

**Stipulation #21 Deferred Bonus Payments**

In addition to all other bonus bids or bonus payments specified in this lease, Lessee agrees to pay a deferred bonus upon each ton of coal in excess of 41,660,000 tons produced from the Leased Premises. The deferred bonus bid will be payable on a cents per ton basis at the time of production. The per ton deferred bonus will be calculated as a fraction, the numerator of which is the total initial bonus bid offered by the lessee and accepted by Lessor for this lease and the lease of trust lands in Section 16 of T. 17 S., R. 6 E., SLB&M, expressed in dollars, and the denominator of which is 48,535,000. Deferred bonuses shall accrue only as such coal is actually produced, and payments shall be timely made in the same manner as Royalty Payments specified in paragraph 6.4 of this lease. Each deferred bonus payment shall be adjusted for inflation, from the Effective Date of the lease, on the basis of the non-seasonally adjusted Producers Price Index (PPI) for Bituminous Coal and Lignite, contained in the Fuels and related products and power Group (Series ID: WPU0512) as published, whether Preliminary or not, by the U.S. Department of Labor, Bureau of Labor Statistics for the month immediately preceding the month in which such deferred bonus payment accrues. If such PPI index ceases to be published in the future then Lessor may determine and specify to Lessee the closest PPI Series-Group-Item, then published by the U.S. Department of Labor, Bureau of Labor Statistic, to serve in its place.

**END OF SPECIAL STIPULATIONS**

# AMENDMENT NO. 1 TO
# MINERAL LEASE 51191-OBA

**Fund:** Multi

This AMENDMENT NO. 1 TO MINERAL LEASE NO. 51191-OBA ("Amendment") is entered into as of the 1st day of February 2018, by and between the STATE OF UTAH, acting by and through the SCHOOL AND INSTITUTIONAL TRUST LANDS ADMINISTRATION, 675 East 500 South, Suite 500, Salt Lake City, UT 84102 ("LESSOR"), and Fossil Rock Resources LLC, 6011 Dutchman Lane, 9th Floor, Louisville, KY 40205 ("LESSEE").

**Recitals**

A. Effective January 25, 2008, LESSOR and LESSEE's predecessor-in-interest entered into Mineral Lease No. 51191-OBA (the "Lease"). The Lease grants LESSEE the right mine and remove coal (the "leased mineral") located on certain trust lands described therein (the "Lease Area").

B. LESSOR now wishes to amend the Lease to add update certain language within Section 9.2, as per request of the United States, Department of the Interior, Bureau of Land Management.

NOW THEREFORE, in consideration of the mutual promises and covenants contained herein, and of other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, LESSOR and LESSEE hereby amend the Lease as follows:

1. Federal Agency Name Change. The reference within Section 9.2 of the Lease, titled Regulation Upon Reversion, which refers to "the Minerals Management Service" is hereby changed to "the Office of Natural Resource Revenue."

2. Miscellaneous. Except as expressly modified by the provisions of this Amendment, the Lease shall continue in full force and effect. All initial capitalized terms in this Amendment shall have the same meaning given such terms in the Lease, unless otherwise defined in this Amendment. In the event any inconsistencies exist between the terms of this Amendment and the Lease, this Amendment shall control. The individuals who execute this Amendment represent and warrant that they are duly authorized to execute this Amendment on behalf of the LESSOR and LESSEE, as the case may be, and no other signature, act or authorization is necessary to bind such entities to the provisions of this Amendment.

IN WITNESS WHEREOF, the parties have entered into this Amendment on the date first set forth above.

LESSOR: STATE OF UTAH
School and Institutional Trust Lands Administration

By: _____
ASSISTANT DIRECTOR, MINERALS
THOMAS B. FADDIES

LESSEE: FOSSIL ROCK RESOURCES LLC

By: _____

APPROVED AS TO FORM:
SEAN D. REYES
UTAH ATTORNEY GENERAL

By: _____
Special Assistant Attorney General

STATE OF UTAH )
:
COUNTY OF SALT LAKE )

The foregoing instrument was acknowledged before me this 10th day of April 2018, by Thomas B. Faddies, in his capacity as Assistant Director of Minerals of the School and Institutional Trust Lands Administration.

Aly Gold
Notary Public

ALY GOLD
Notary Public State of Utah
My Comm. Exp: June 18, 2019
Comm. Number: 683597

STATE OF Colorado )
:
COUNTY OF Mesa )

The foregoing instrument was acknowledged before me this 4th day of April 2018, by Gene DiClaudio, in his/her capacity as COO of the LESSEE.

Kathleen Widner
Notary Public

KATHLEEN WIDNER
Notary Public
State of Colorado
Notary ID 19944011144
My Commission Expires Aug 3, 2018

STATE OF _____ )
:
COUNTY OF _____ )

The foregoing instrument was acknowledged before me this _____ day of _____ 20____, by _____, LESSEE.

_____
Notary Public

GRANT: **School**

# UTAH STATE LEASE FOR COAL
# ML 51192-OBA

## COTTONWOOD COMPETITIVE LEASING UNIT
## PARCEL #2 (NON-REVERSIONARY TRACT)

THIS COAL MINING LEASE AND AGREEMENT (the "Lease") is entered into and executed in duplicate as of January 18, 2008 (the "Effective Date") by and between the STATE OF UTAH, acting by and through the SCHOOL AND INSTITUTIONAL TRUST LANDS ADMINISTRATION, 675 East 500 South, Suite 500, Salt Lake City, Utah 84102 ("Lessor"), and

**Ark Land Company**
**One CityPlace Drive - Suite 300**
**St. Louis, MO 63141**

having a business address as shown above ("Lessee").

WITNESSETH:

That the State of Utah, as Lessor, in consideration of the rentals, royalties, and other financial consideration paid or required to be paid by Lessee, and the covenants of Lessee set forth below, does hereby GRANT AND LEASE to Lessee the exclusive right and privilege to explore for, drill for, mine, remove, transport, convey, cross-haul, commingle, and sell the coal located within the boundaries of the following-described tract of land (the "Leased Premises") located in Emery County, State of Utah:

Township 17 South, Range 6 East, SLB&M
Section 16: E2, SW4, S2NW4, NW4NW4

Containing 600.00 acres, more or less.

Together with the right and privilege to make use of the surface (but only to the extent owned by Lessor) and subsurface of the Leased Premises for uses incident to the mining of coal by Lessee on the Leased Premises or on other lands under the control of Lessee or mined in connection with operations on the Leased Premises, including, but not limited to, conveying, storing, loading, hauling, commingling, cross-hauling, and otherwise transporting coal; excavating; removing, stockpiling, depositing and redepositing of surface materials; and the subsidence, mitigation, restoration and reclamation of the surface.

This Coal Mining Lease and Agreement is subject to, and Lessee hereby agrees to and accepts, the following covenants, terms, and conditions:

1. LEASED MINERALS.

1.1 Coal. This mineral lease covers coal, which shall mean and include black or brownish-black solid fossil fuels that have been subjected to the natural processes of coalification, and which fall within the classification of coal by rank as anthracitic, bituminous, sub-bituminous, or lignitic,

together with closely associated substances which include, but are not limited to other hydrocarbon substances physically contained within the same geologic strata as the coal. In the event that minerals other than coal are discovered during lease operations, Lessee shall promptly notify the Lessor.

1.2 Coalbed Methane. To the extent that Lessor owns gas, coalbed methane or coal seam gas (collectively "coalbed methane") within the Leased Premises, Lessee may remove, vent, flare or capture such coalbed methane from the coal strata being mined and any overlying formations if such removal is necessary for safety reasons in the reasonable discretion of Lessee. If Lessee captures or uses such coalbed methane, it shall pay Lessor royalties on the value of such coalbed methane at the prevailing state royalty rate for natural gas, unless such royalties are expressly waived by Lessor. In the event that Lessor does not own coalbed methane within the Leased Premises, Lessee must obtain the consent of the owner of such coalbed methane prior to removal or capture of such gas. Except as expressly granted herein, the right to extract gas, coalbed methane and coal seam gas is not granted by this Lease.

1.3 No Warranty of Title. Lessor claims title to the mineral estate covered by this Lease. Lessor does not warrant title nor represent that no one will dispute the title asserted by Lessor. It is expressly agreed that Lessor shall not be liable to Lessee for any alleged deficiency in title to the mineral estate, nor shall Lessee become entitled to any refund for any rentals, bonuses, or royalties paid under this Lease in the event of title failure.

2. RESERVATIONS TO LESSOR. Subject to the exclusive rights and privileges granted to Lessee under this Lease, and further provided that Lessor shall refrain from taking actions with respect to the Leased Premises that may unreasonably interfere with Lessee' s operations, Lessor hereby excepts and reserves from the operation of this Lease the following rights and privileges (to the extent that Lessor has the right to grant such rights and privileges):

2.1 Rights-of-Way and Easements. Lessor reserves the right, following consultation with the Lessee, to establish rights-of-way and easements upon, through or over the Leased Premises, under terms and conditions that will not unreasonably interfere with operations under this Lease, for roads, pipelines, electric transmission lines, transportation and utility corridors, mineral access, and any other purpose deemed reasonably necessary by Lessor.

2.2 Other Mineral Leases. Lessor reserves the right to enter into mineral leases and agreements with third parties covering minerals other than coal, under terms and conditions that will not unreasonably interfere with operations under this Lease in accordance with Lessor' s regulations, if any, governing multiple mineral development.

2.3 Use and Disposal of Surface. To the extent that Lessor owns the surface estate of the Leased Premises and subject to the rights granted to the Lessee pursuant to this Lease, Lessor reserves the

right to use, lease, sell, or otherwise dispose of the surface estate or any part thereof. Lessor shall notify Lessee of any such sale, lease, or other disposition of the surface estate.

2.4 Previously Authorized Improvements. If authorized improvements have been placed upon the Leased Premises by a third party prior to the commencement of this Lease, Lessee shall allow the owner of such improvements to remove them within ninety (90) days after the Lease term commences. Nothing in this paragraph shall authorize Lessee to remove surface improvements where Lessor does not own the surface estate.

2.5 Rights Not Expressly Granted. Lessor further reserves all rights and privileges of every kind and nature, except as specifically granted in this Lease.

3. TERM OF LEASE; READJUSTMENT.

3.1 Primary Term. This Lease is granted for a "primary term" of ten (10) years commencing on the Effective Date and for a "secondary term" of an additional ten (10) years, subject to Lessee's compliance with the requirements of paragraph 3.3, Diligent Operations; Minimum Royalty.

3.2 Extension Beyond Secondary Term. Subject to Lessee's compliance with the other provisions of this Lease, this Lease shall remain in effect beyond the secondary term and for as long thereafter as coal is produced in commercial quantities from the Leased Premises, or from lands constituting either (i) a logical mining unit approved by the Bureau of Land Management containing the Leased Premises, or (ii) a mining unit, in which the recoverable coal reserves can be developed in an efficient, economical and orderly manner as a unit with due regard to the conservation of recoverable coal reserves. The second type of mining unit requires a determination by the Lessor that the criteria set forth in item (ii) have been satisfied. The satisfaction of either (i) or (ii) above shall mean that the Lease is contained within an "approved mining unit". For the purposes of this Lease, production of coal in commercial quantities shall mean production during each lease year of at least one per cent (1%) of the recoverable coal reserves within the Leased Premises or within lands constituting an approved mining unit which includes the Leased Premises, as such recoverable coal reserves are determined by Lessor after consultation with Lessee, subject to adjustment from time to time based upon reasonable justification from the Lessee.

3.3 Diligent Operations; Minimum Royalty. In the absence of actual production in commercial quantities as set forth in paragraph 3.2, Extension Beyond Secondary Term, this Lease shall remain in effect beyond the primary term only if the Lessee is engaged in diligent operations, exploration, research, or development activity (which development activity shall include, but not be limited to, pursuit of required permits and approvals) which in Lessor's reasonable discretion is calculated to advance development or production of coal from the Leased Premises or lands constituting an approved mining unit which includes the Leased Premises, and Lessee pays an annual minimum royalty in advance on or before the anniversary date of the Effective Date. The

minimum royalty shall be calculated by determining the production royalty that would be payable upon production of one per cent (1%) of the recoverable coal reserves within the Leased Premises, as such recoverable coal reserves are determined by Lessor after consultation with Lessee, subject to adjustment from time to time based upon reasonable justification from the Lessee. The unit value of the recoverable coal reserves for purposes of determining the minimum royalty shall be determined by Lessor using the methodology set forth in 43 C.F.R. 3483.4(c)(1)-(3) (1998). Minimum royalties paid by Lessee pursuant to this paragraph may be credited against production royalties accruing during the term of this Lease.

3.4 Expiration; Cessation of Production. This Lease may not be extended pursuant to paragraph 3.3, Diligent Operations; Minimum Royalty, beyond the end of the twentieth year after the Effective Date except by the actual production of coal in commercial quantities from the Leased Premises or from lands constituting an approved mining unit which includes the Leased Premises. After expiration of the secondary term, this Lease will expire of its own terms, without the necessity of any notice or action by Lessor, if Lessee ceases production of coal in commercial quantities for an entire lease year, unless the Lease is suspended pursuant to paragraph 16.3, Suspension.

3.5 Readjustment. At the end of the primary term and at the end of each period of ten (10) years thereafter, Lessor may readjust the terms and conditions of this Lease (including without limitation rental rates, minimum royalties, royalty rates and valuation methods, and provisions concerning reclamation). If within thirty (30) days after submission of the readjusted lease terms to the Lessee, the Lessee determines that any or all of the proposed readjusted terms and conditions are unacceptable, then Lessee shall so notify Lessor in writing and the parties shall attempt to resolve the objectionable term or condition. If the parties are unable to resolve the matter and agree upon the readjusted terms and conditions submitted by Lessor at the end of such ten (10) year period, Lessee shall forfeit any right to the continued extension of this lease, and the lease shall automatically terminate, provided that nothing herein shall be deemed to preclude Lessee from appealing any readjustment by Lessor pursuant to applicable law

3.6 Relinquishment. Lessee may relinquish all or portions of this Lease at any time by filing a written notice of relinquishment with Lessor. Lessor may disapprove any relinquishment if Lessee has failed to pay all rentals, royalties, and other amounts due and owing to the Lessor, if the lease is otherwise not in good standing, or if relinquishment would in Lessor's reasonable determination cause waste of economically recoverable coal. Lessee may not relinquish parcels smaller than a quarter-quarter section or surveyed lot. Upon approval, relinquishment shall relieve the Lessee of all future rental obligations as to the relinquished lands effective as of the date of filing of the relinquishment, but shall not relieve Lessee from other obligations to the extent provided in paragraph 15.2, Effect of Termination.

4. BONUS BID. Lessee agrees to pay Lessor, an initial bonus bid in the sum of $3,545,714.00 as partial consideration for Lessor's issuance of this Lease, payable in five equal annual installments of $709,142.80. The first annual installment shall be due with Lessee's application to lease and the unpaid

balance of the bonus bid shall be paid in equal installments on or before the next four successive anniversaries of the Effective Date of the lease. The bonus bid shall not bear interest; provided, however, that if this Lease is relinquished or otherwise terminated prior to the payment in full of the bonus bid, or if Lessee fails to make any bonus bid payment when due, the entire unpaid balance of the bonus bid shall immediately become due without regard to such relinquishment or termination, and such balance shall thereafter bear interest as provided in paragraph 16.2, Interest. Lessor may require Lessee to submit a bond or other sufficient surety to secure Lessee's obligation to pay the unpaid balance of the bonus bid. The initial bonus bid may not be credited against any other bonus payments, annual rentals or royalties accruing under the lease.

5. RENTALS. Lessee agrees to pay Lessor an annual rental of three dollars ($3.00) for each acre and fractional part thereof within the Leased Premises. Lessee shall promptly pay annual rentals each year in advance on or before the anniversary date of the Effective Date. Lessee may not credit rentals against production royalties or against minimum royalties payable pursuant to paragraph 3.3, Diligent Operations; Minimum Royalty.

6. ROYALTIES.

6.1 Production Royalties. Lessee shall pay Lessor a production royalty of eight per cent (8%) of the value of all coal severed and removed from the Leased Premises. For all coal sold pursuant to an arm's-length contract, value shall be determined on the basis of the gross proceeds received by Lessee from the sale or disposition of such coal. Gross proceeds shall include all bonuses, allowances or other consideration of any nature received by Lessee for coal actually produced. For any coal that is sold or disposed of other than by an arms-length contract, or for coal that is used within the mine permit area containing the Leased Premises for generation of electricity or for gasification, liquefaction, in situ processing, or other method of extracting energy from such coal, the value of such coal shall be determined by Lessor with reference to (in order of priority): (i) comparable arms-length contracts or other dispositions of like-quality coal produced in the same coal field; (ii) prices reported for that coal to a public utility commission; (iii) prices reported to other governmental agencies; or (iv) other relevant information.

6.2 Allowable Deductions. It is expressly understood and agreed that none of Lessee's mining or production costs, including but not limited to costs for materials, labor, overhead, distribution, transportation within the mine permit area prior to the point of sale, loading, crushing, sizing, screening, or general and administrative activities, may be deducted in computing Lessor's royalty. All such costs shall be entirely borne by Lessee and are anticipated by the rate of royalty set forth in this Lease. In the event that the point of sale for coal produced from this Lease is located outside the mine permit area boundary, Lessee may deduct the reasonable, actual costs of transportation of such coal from the mine permit area boundary to the point of sale from gross proceeds in computing Lessor's royalty; provided, however, that transportation deductions for coal transported by Lessee, Lessee's affiliates, or by non-arm's-length contract are subject to

review and modification by Lessor. Lessee shall be allowed to deduct its actual, reasonable washing and treatment costs from gross proceeds in computing Lessor's royalty; provided, however, that, upon Lessor's request Lessee shall provide to Lessor appropriate justification to demonstrate that Lessee's costs are reasonable.

6.3 Reference to Federal Regulations. It is the intent of Lessor and Lessee that the calculation of the value of coal for royalty purposes be consistent with federal coal regulations governing the valuation of coal, except where this Lease expressly provides otherwise. In no event shall the value of coal used for calculation of royalties under this Lease be less than the value which would be obtained were federal royalty valuation regulations applied.

6.4 Royalty Payment. For all coal severed and removed from the Leased Premises that is used, sold, transported or otherwise disposed of during a particular month, Lessee shall pay royalties to Lessor on or before the end of the next succeeding month. Royalty payments shall be accompanied by a verified statement, in a form approved by Lessor, stating the amount of coal sold or otherwise disposed of, the gross proceeds accruing to Lessee, the calculation of allowable deductions, and any other information reasonably required by Lessor to verify production and disposition of the coal or coal products. In the event that Lessee uses or disposes of coal pursuant to a non-arm's-length contract, or uses coal for generation of electricity or for gasification, liquefaction, in situ processing, or other method of extracting energy from such coal, Lessee shall notify Lessor of such use or disposal on or before the end of the next succeeding month following such use or disposal, and shall pay royalties upon Lessee's good faith estimate of the value of such coal, subject to Lessor's right to determine the value of such coal pursuant to paragraph 6.1, Production Royalties.

6.6 Suspension, Waiver or Reduction of Rents or Royalties. Lessor, to the extent not prohibited by applicable law, is authorized to waive, suspend, or reduce the rental or minimum royalty, or reduce the royalty applicable with respect to the entire Lease, whenever in Lessor's judgment it is necessary to do so in order to promote development, or whenever in the Lessor's judgment the Lease cannot be successfully operated under the terms provided herein.

7. RECORDKEEPING; INSPECTION; AUDITS.

7.1 Registered Agent; Records. Lessee shall maintain a registered agent within the State of Utah to whom any and all notices may be sent by Lessor and upon whom process may be served. Lessee shall also maintain an office within the State of Utah containing originals or copies of all maps, engineering data, permitting materials, books, records or contracts (whether such documents are in paper or electronic form) generated by Lessee that pertain in any way to coal production, output and valuation; mine operations; coal sales and dispositions; transportation costs; and calculation of royalties from the Leased Premises. Lessee shall maintain such documents for at least seven years after the date of the coal production to which the documents pertain.

7.2 Inspection. Lessor's employees and authorized agents at Lessor's sole risk and expense shall have the right to enter the Leased Premises to check scales as to their accuracy, and to go on any part of the Leased Premises to examine, inspect, survey and take measurements for the purposes of verifying production amounts and proper lease operations. Upon reasonable notice to Lessee, Lessor's employees and authorized agents shall further have the right to audit, examine and copy (at Lessor's expense) all documents described in paragraph 7.1, Registered Agent; Records, whether such documents are located at the mine site or elsewhere. Lessee shall furnish all conveniences necessary for said inspection, survey, or examination; provided, however, that such inspections shall be conducted in a manner that is in conformance with all applicable mine safety regulations and does not unreasonably interfere with Lessee's operations.

7.3 Geologic Information. In the event Lessee conducts core-drilling operations or other geologic evaluation of the Leased Premises, Lessor may inspect core samples, evaluations thereof, and proprietary geologic information concerning the Leased Premises.

7.4 Confidentiality. Any and all documents and geologic data obtained by Lessor through the exercise of its rights as set forth in paragraphs 7.2, Inspection., and 7.4, Geologic Information., may be declared confidential information by Lessee, in which event Lessor and its authorized agents shall maintain such documents and geologic data as protected records under the Utah Governmental Records Access Management Act or other applicable privacy statute and shall not disclose the same to any third party without the written consent of Lessee, the order of a court of competent jurisdiction requiring such disclosure, or upon termination of this Lease.

8. USE OF SURFACE ESTATE.

8.1 Lessor-Owned Surface. If Lessor owns the surface estate of all or some portion of the Leased Premises, by issuance of this Lease the Lessee has been granted the right to make use of such lands to the extent reasonably necessary and expedient for the economic operation of the leasehold. Lessee's right to surface use of Lessor-owned surface estate shall include the right to subside the surface. Such surface uses shall be exercised subject to the rights reserved to Lessor as provided in paragraph 2, RESERVATIONS TO LESSOR, and without unreasonable interference with the rights of any prior or subsequent lessee of Lessor.

8.2 Split-Estate Lands. If Lessor does not own the surface estate of any portion of the Leased Premises, Lessee's access to and use of the surface of such lands shall be determined by applicable law governing mineral development on split-estate lands, including without limitation applicable statutes governing access by mineral owners to split estate lands, and reclamation and bonding requirements. Lessee shall indemnify, defend and hold Lessor harmless for all claims, causes of action, damages, costs and expenses (including attorney's fees and costs) arising out of

or related to damage caused by Lessee's operations to surface lands or improvements owned by third parties.

9. APPLICABLE LAWS AND REGULATIONS; HAZARDOUS SUBSTANCES

9.1 Trust Lands Statute and Regulations. This Lease is issued pursuant to the provisions of Title 53C, Utah Code Annotated, 1953, as amended, and Lessee is subject to and shall comply with all current and future rules and regulations adopted by the School and Institutional Trust Lands Administration and its successor agencies.

9.2 Other Applicable Laws and Regulations. Lessee shall comply with all applicable federal, state and local statutes, regulations, and ordinances, including without limitation the Utah Coal Mining and Reclamation Act, applicable statutes and regulations relating to mine safety and health, and applicable statutes, regulations and ordinances relating to public health, pollution control, management of hazardous substances and environmental protection.

9.3 Hazardous Substances. Lessee [or other occupant pursuant to any agreement authorizing mining] shall not keep on or about the premises any hazardous substances, as defined under 42 U.S.C. 9601(14) or any other Federal environmental law, any regulated substance contained in or released from any underground storage tank, as defined by the Resource Conservation and Recovery Act, 42 U.S.C. 6991, *et seq,* or any substances defined and regulated as "hazardous" by applicable State law, (hereinafter, for the purposes of this Lease, collectively referred to as "Hazardous Substances") unless such substances are reasonably necessary in Lessee's mining operations, and the use of such substances or tanks is noted and approved in the Lessee's mining plan, and unless Lessee fully complies with all Federal, State and local laws, regulations, statutes, and ordinances, now in existence or as subsequently enacted or amended, governing Hazardous Substances. Lessee shall immediately notify Lessor and any other Federal, State and local agency with jurisdiction over the Leased Premises, or contamination thereon, of (i) all reportable spills or releases of any Hazardous Substance affecting the Leased Premises, (ii) all failures to comply with any applicable Federal, state or local law, regulation or ordinance governing Hazardous Substances, as now enacted or as subsequently enacted or amended, (iii) all inspections of the Leased Premises by, or any correspondence, order, citations, or notifications from any regulatory entity concerning Hazardous Substances affecting the Leased Premises, (iv) all regulatory orders or fines or all response or interim cleanup actions taken by or proposed to be taken by any government entity or private Party concerning the Leased Premises.

9.4 Hazardous Substances Indemnity. Lessee [or other occupant pursuant to any agreement authorizing mining] shall indemnify, defend, and hold harmless Lessor its agencies, employees, officers, and agents with respect to any and all damages, costs, liabilities, fees (including attorneys' fees and costs), penalties (civil and criminal), and cleanup costs arising out of or in any way related to Lessee's use, disposal, transportation, generation, sale or location upon or

affecting the Leased Premises of Hazardous Substances, as defined in paragraph 9.4 of this Lease. This indemnity shall extend to the actions of Lessee's employees, agents assigns, sublessees, contractors, subcontractors, licensees and invitees. This indemnity is in addition to, and in no way limits, the general indemnity contained in paragraph 16.1 of this Lease.

9.5 Waste Certification. The Lessee shall provide upon abandonment, transfer of operation, assignment of rights, sealing-off of a mined area, and prior to lease relinquishment, certification to the Lessor, based upon a complete search of all the operator's records for the Lease, and upon its knowledge of past operations, there have been no reportable quantities of hazardous substances as defined in 40 C.F.R. 302.4, or used oil as defined in Utah Administrative Code R315-15, discharged (as defined at 33 U.S.C. 1321(a)(2)), deposited or released within the Leased Premises, either on the surface or underground, and that all remedial actions necessary have been taken to protect human health and the environment with respect to such substances. Lessee shall additionally provide to Lessor a complete list of all hazardous substances, hazardous materials, and their respective Chemical Abstracts Service Registry Numbers, and oil and petroleum products used or stored on, or delivered to, the Leased Premises. Such disclosure will be in addition to any other disclosure required by law or agreement.

10. BONDING.

10.1 Lease Bond Required. At the request of Lessor, at or at the time or anytime after this lease is executed, Lessee shall execute and file with the Lessor a good and sufficient bond or other financial guarantee acceptable to Lessor in order to: (a) guarantee Lessee's performance of all covenants and obligations under this Lease, including Lessee's obligation to pay royalties; and (b) ensure compensation for damage, if any, to the surface estate and any surface improvements.

10.2 Reclamation Bonding. The bond filed with the Utah Division of Oil, Gas and Mining ("UDOGM") in connection with the issuance of a mine permit which includes the Leased Premises shall be deemed to satisfy Lessor's bonding requirements with respect to Lessee's reclamation obligations under this Lease; provided, however, upon notice to Lessee and a public hearing with respect to the basis for its decision, the Lessor may, in its reasonable discretion, determine that the bond filed with UDOGM is insufficient to protect Lessor's interests. In such an event the Lessor shall enter written findings as to the basis for its calculation of the perceived insufficiency and enter an order establishing the amount of additional bonding required. Lessee shall file any required additional bond with Lessor within thirty (30) days after demand by Lessor. Lessor may increase or decrease the amount of any additional bond from time to time in accordance with the same procedure. Lessee may combine any additional bond required under this paragraph with the original lease bond filed under Paragraph 10.1, Lease Bond Required.

10.3 Release of Additional Bond. Any additional bond required by Lessor pursuant to 10.2, Reclamation Bonding, may be released by Lessor at any time and shall be released no later than the time of final bond release by UDOGM with respect to the Leased Premises.

11. WATER RIGHTS.

11.1 Water Rights in Name of Lessor. If Lessee files to appropriate water for coal mining operations on the Leased Premises, the filing for such water right shall be made by Lessee in the name of Lessor at no cost to Lessor, and such water right shall become an appurtenance to the Leased Premises, subject to Lessee's right to use such water right at no cost during the term of this Lease.

11.2 Option to Purchase. If Lessee purchases or acquires an existing water right for coal mining operations on the Leased Premises, Lessor shall have the option to acquire that portion of such water right as was used on the Leased Premises upon expiration or termination of this Lease. The option price for such water right shall be the fair market value of the water right as of the date of expiration or termination of this Lease. Upon expiration or termination of this Lease, Lessee shall notify Lessor in writing of all water rights purchased or acquired by Lessee for coal mining operations on the Leased Premises and its estimate of the fair market value of such water right. Lessor shall then have forty-five (45) days to exercise its option to acquire the water by payment to Lessee of the estimated fair market value. If Lessor disagrees with Lessee's estimate of fair market value, Lessor shall notify Lessee of its disagreement within the 45 day option exercise period. The fair market value of the water right shall then be appraised by a single appraiser mutually acceptable to both parties, which appraisal shall be final and not subject to review or appeal. If the parties cannot agree upon the choice of an appraiser, the fair market value of the water right shall be determined by a court of competent jurisdiction. Conveyance of any water right pursuant to this paragraph shall be by quit claim deed.

12. ASSIGNMENT OR SUBLEASE; OVERRIDING ROYALTIES.

12.1 Consent Required. Lessee shall not assign or sublease this Lease in whole or in part, or otherwise assign or convey any rights or privileges granted by this Lease, including, without limitation, creation of overriding royalties or production payments, without the prior written consent of Lessor. Any assignment, sublease or other conveyance made without prior written consent of Lessor shall have no legal effect unless and until approved in writing by Lessor. Exercise of any right with respect to the Leased Premises in violation of this provision shall constitute a default under this Lease.

12.2 Binding Effect. All of the terms and provisions of this Lease shall be binding upon and shall inure to the benefit of their respective successors, assigns, and sublessees.

12.3 Limitation on Overriding Royalties. Lessor reserves the right to disapprove the creation of an overriding royalty or production payment that would, in Lessor's reasonable discretion, constitute an unreasonable economic burden upon operation of the Lease. In exercising its discretion to disapprove the creation of an overriding royalty, Lessor shall consult with Lessee and any third parties involved and shall prepare findings to evidence the basis of its decision. Cumulative overriding royalties of 2% or less shall be deemed presumptively reasonable unless special circumstances are shown by Lessor to exist.

13. OPERATIONS.

13.1 Permitting. Before Lessee commences exploration, drilling, or mining operations on the Leased Premises, it shall have obtained such permits and posted such bonds as may be required under applicable provisions of the Utah Coal Mining and Reclamation Act, the Surface Mining Control and Reclamation Act, and associated regulations, together with applicable regulations of the surface management agency. Lessee shall maintain any required permits in place for the duration of mining operations and reclamation. Upon request, Lessee shall provide Lessor with a copy of all regulatory filings relating to permitting matters.

13.2 Plan of Operations. Prior to the commencement of any underground mining operations on the Leased Premises, Lessee shall obtain Lessor's approval of a plan of operations for the Leased Premises. The plan of operations shall contain all information required to be contained in a federal Resource Recovery and Protection Plan, as described in 43 C.F.R. • 3482.1(b) and (c) (1998). Lessor may modify the proposed plan of operations as is needed to insure that there is no waste of economically recoverable coal reserves contained on the Leased Premises. In this context "waste" shall mean the inefficient utilization of, or the excessive or improper loss of an otherwise economically recoverable coal resource. Lessor shall notify Lessee in writing of its approval or modifications of the plan of operations. The plan of operations submitted by Lessee shall be deemed approved by Lessor if Lessor has not otherwise notified Lessee within sixty (60) days of filing.

13.3 Plan of Operations - Modification. In the event that material changes are required to the plan of operations during the course of mining, Lessee shall submit a modification of the plan of operations to the Lessor. Routine adjustments to the plan of operations based upon geologic circumstances encountered during day-to-day mining operations do not require the submission of a modification. If the proposed changes require emergency action by Lessor, then the Lessee shall so notify the Lessor at the time of submission of the modification and the parties shall use their best efforts to meet the Lessee's time schedule regarding implementation of the changes. Non-emergency modifications will be reviewed promptly by Lessor to insure that there is no waste of economically recoverable coal reserves pursuant to the plan of operations, as modified, and Lessor shall notify lessee in writing of its approval or modification of the proposed modification.

13.4 Mine Maps. Lessee shall maintain at the mine office clear, accurate, and detailed maps of all actual and planned operations prepared and maintained in the manner prescribed by 43 C.F.R. 3482.3 (1998). Lessee shall provide copies of such maps to Lessor upon request.

13.5 Good Mining Practices. Lessee shall conduct exploration and mining operations on the Leased Premises in accordance with standard industry operating practices, and shall avoid waste of economically recoverable coal. Lessee shall comply with all regulations and directives of the Mine Safety and Health Administration or successor agencies for the health and safety of employees and workers. Lessee shall further comply with the performance standards for underground resource recovery set forth at 43 C.F.R. 3484.1(c) (1998); provided, however, that Lessor may waive such standards from time to time in its reasonable discretion, upon request by Lessee. Coal shall be mined from this Lease by underground methods only.

13.6 Mining Units. Lessor may approve the inclusion of the Leased Premises in a mining unit with federal, private or other non-state lands upon terms and conditions that it deems necessary to protect the interests of the Lessor, including without limitation segregation of production, accounting for commingled coal production, and minimum production requirements or minimum royalties for the Leased Premises.

14. EQUIPMENT; RESTORATION.

14.1 Equipment. Upon termination of this Lease, Lessee shall remove, and shall have the right to remove, all improvements, equipment, stockpiles, and dumps from the Leased Premises within six (6) months; provided, however, that Lessor may, at Lessor's sole risk and expense, and subject to Lessee's compliance with requirements imposed by UDOGM and MSHA, require Lessee to retain in place underground timbering supports, shaft linings, rails, and other installations reasonably necessary for future mining of the Leased Premises. All improvements and equipment remaining on the Leased Premises after six (6) months may be deemed forfeited to Lessor upon written notice of such forfeiture to Lessee. Lessee may abandon underground improvements, equipment of any type, stockpiles and dumps in place if such abandonment is in compliance with applicable law, and further provided that Lessee provides Lessor with financial or other assurances sufficient in Lessor's reasonable discretion to protect Lessor from future environmental liability with respect to such abandonment or any associated hazardous waste spills or releases. Lessee shall identify and locate on the mine map the location of all equipment abandoned on the Lease Premises.

14.2 Restoration and Reclamation. Upon termination of this Lease, Lessee shall reclaim the Leased Premises in accordance with the requirements of applicable law, including mine permits and reclamation plans on file with UDOGM. Lessee shall further abate any hazardous condition on or associated with the Leased Premises. Lessee and representatives of all governmental agencies

having jurisdiction shall have the right to re-enter the Leased Premises for reclamation purposes for a reasonable period after termination of the Lease.

15. DEFAULT

15.1 Notice of Default; Termination. Upon Lessee's violation of or failure to comply with any of the terms, conditions or covenants set forth in this Lease, Lessor shall notify Lessee of such default by registered or certified mail, return receipt requested, at the last address for Lessee set forth in Lessor's files. Lessee shall then have thirty (30) days, or such longer period as may be granted in writing by Lessor, to either cure the default or request a hearing pursuant to the Lessor's administrative adjudication rules. In the event Lessee fails to cure the default or request a hearing within the specified time period, Lessor may cancel this Lease without further notice to or appeal by Lessee.

15.2 Effect of Termination. The termination of this Lease for any reason, whether through expiration, cancellation or relinquishment, shall not limit the rights of the Lessor to recover any royalties and/or damages for which Lessee may be liable, to recover on any bond on file, or to seek injunctive relief to enjoin continuing violations of the Lease terms. No remedy or election under this Lease shall be deemed exclusive, but shall, wherever possible, be cumulative with all other remedies available under this Lease, at law, or in equity. Lessee shall surrender the Leased Premises upon termination; however, the obligations of Lessee with respect to reclamation, indemnification and other continuing covenants imposed by this Lease shall survive the termination.

16. MISCELLANEOUS PROVISIONS.

16.1 Indemnity. Except as limited by paragraph 7.2, Inspection, Lessee shall indemnify and hold Lessor harmless for, from and against each and every claim, demand, liability, loss, cost, damage and expense, including, without limitation, attorneys' fees and court costs, arising in any way out of Lessee's occupation and use of the Leased Premises, including without limitation claims for death, personal injury, property damage, and unpaid wages and benefits. Lessee further agrees to indemnify and hold Lessor harmless for, from and against all claims, demands, liabilities, damages and penalties arising out of any failure of Lessee to comply with any of Lessee's obligations under this Lease, including without limitation attorneys' fees and court costs.

16.2 Interest. Except as set forth in paragraph 4, BONUS BID, interest shall accrue and be payable on all obligations arising under this Lease at such rate as may be set from time to time by rule enacted by Lessor. Interest shall accrue and be payable, without necessity of demand, from the date each such obligation shall arise.

16.3 Suspension. In the event that Lessor in its reasonable discretion determines that suspension is necessary in the interests of conservation of the coal resource, or if Lessee has been prevented from performing any of its obligations or responsibilities under this Lease or from conducting mining operations by labor strikes, fires, floods, explosions, riots, any unusual mining casualties or conditions, Acts of God, government restrictions or orders, severe weather conditions, or other extraordinary events beyond its control, then the time for performance of this Lease by Lessee shall be suspended during the continuance of such acts which prevent performance, excepting any payments due and owing to Lessor.

16.4 Consent to Suit; Jurisdiction. (i) this Lease shall be governed by the laws of the State of Utah; (ii) Lessor and Lessee agree that all disputes arising out of this Lease shall be litigated only in the Third Judicial District Court for Salt Lake County, Utah; (iii) Lessee consents to the jurisdiction of such court; and (iv) Lessee shall not bring any action against Lessor without exhaustion of available administrative remedies and compliance with applicable requirements of the Utah Governmental Immunity Act.

16.5 No Waiver. No waiver of the breach of any provision of this Lease shall be construed as a waiver of any preceding or succeeding breach of the same or any other provision of this Lease, nor shall the acceptance of rentals or royalties by Lessor during any period of time in which Lessee is in default be deemed to be a waiver of such default.

16.6 Severability. The invalidity of any provision of this Lease, as determined by a court of competent jurisdiction, shall in no way affect the validity of any other provision hereof.

16.7 Entire Lease. This Lease, together with any attached stipulations, sets forth the entire agreement between Lessor and Lessee with respect to the subject matter of this Lease. No subsequent alteration or amendment to this Lease shall be binding upon Lessor and Lessee unless in writing and signed by each of them.

IN WITNESS WHEREOF, the parties have executed this Lease as of the date hereinabove first written.

APPROVED AS TO FORM:
MARK L. SHURTLEFF
ATTORNEY GENERAL

By: _____

Date: 1/18/06

THE STATE OF UTAH, acting by and through the SCHOOL AND INSTITUTIONAL TRUST LANDS ADMINISTRATION ("LESSOR")

THOMAS B. FADDIES
DIRECTOR/MINERALS

School & Institutional Trust Lands Administration - LESSOR

ARK LAND COMPANY ("LESSEE")

By: _____
Its: PRESIDENT

STATE OF UTAH )
: ss.
COUNTY OF SALT LAKE )

On the 18 day of January, 2008, personally appeared before me Thomas B Faddis who being by me duly sworn did say that he is Assistant Director of the School and Institutional Trust Lands Administration of the State of Utah and the signer of the above instrument, who duly acknowledged that he executed the same.

Given under my hand and seal this 18th day of January 2008.

Alice K Kearney
Notary Public
Residing at:

My commission expires: 5/25/2010

NOTARY PUBLIC
ALICE K. KEARNEY
675 E. 500 S., Suite 500
Salt Lake City, Utah 84102
My Commission Expires
May 25, 2010
STATE OF UTAH

STATE OF ~~UTAH~~ Missouri )
: ss.
COUNTY OF ~~SALT LAKE~~ St. Louis )

On the 21st day of January, 2008, personally appeared before me Steven E. McCurdy, who being duly sworn did say that he is an officer of Ark Land Company and that said instrument was signed in behalf of said corporation by resolution of its Board of Directors, and said that he acknowledged to me that said corporation executed the same.

Given under my hand and seal this 21st day of January, 2008.

Carla A Veizer
Notary Public
Residing at:

My commission expires: 10/28/2010

CARLA A. VEIZER
St. Louis County
NOTARY PUBLIC
Comm # 06427085
NOTARY SEAL
My Commission Expires 10-28-2010
STATE OF MISSOURI

Access to the coal reserves would be from existing underground workings in the adjacent leases. Mine water discharge would be from existing underground workings in the adjacent leases. The discharge would be from an existing permitted discharge point in Cottonwood Canyon.

The Cottonwood Lease Tract, as delineated, reflects an estimated 75 million tons of recoverable coal, assuming a recovery factor of 50 percent. With consideration given only to the stated recoverable coal base, marginal rationale could be generated to support a reasonable foreseeable development of a new mining complex having a mine-life of 15 to 20 years with yearly production of 3.5 to 4 million tons. This new underground mining complex would be similar to the existing Trail Mountain complex and would develop the subject tract with a mining scenario similar to what may be expected by PacifiCorp.

However, no minable coalbed outcrop within the tract boundary exists and any potential independent access would need to be through a shaft or declines. Thus, it is reasonable to conclude that the total cost for: 1) developing coal bed access; 2) developing a new mining complex; and 3) purchasing equipment to achieve its yearly production may make a new mining facility non-competetive in todays market.

# APPENDIX 4-4

# INCIDENTAL BOUNDARY CHANGE

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 4-4

## INCIDENTAL BOUNDARY CHANGE

**Diamond Shamrock**
Coal Company

December 11, 1986

Lowell Braxton
Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center/Suite 350
Salt Lake City, Utah 84180/1203

RE: Trail Mountain Coal Company ACT/015/009 Second Application for Permit Amendment (Incidental Boundary Change)

Dear Lowell;

On October 16, 1986 Trail Mountain Coal Company submitted to the Division a permit amendment for an IBC to increase the ACT/015/009 permit area by six acres. That request was approved by the Division on November 19, 1986.

At this time Trail Mountain Coal Company would formally submit to you and the division a second request for an Incindental Boundary Change (IBC).

Under the IBC criteria, Trail Mountain Coal Company requests an additional increase to the ACT/015/009 permit area of four acres.

This is Trail Mountain Coal Company's second request for an IBC and is a cumulative total of ten acres (which is the maximum acreage allowable under the IBC criteria of UMC 700.5).

This second amendment request is prompted by a series of unplanned events at the Trail Mountain Mine.

1. The Trail Mountain Mine operation consists of two continuous mining machines mining two mining sections (1st South and 6th West) one shift per day.

2 The 6th West continuous miner was taken out of service for a complete rebuild (estimate of 12 weeks).

3 The 2nd South panal was set to mine on November 17, 1986. This section was mined for one week and conditions encountered were such that the section had to be abandoned (low coal, burn, unexceptable quality).

**Trail Mountain Coal Company** A Subsidiary of Diamond Shamrock
P O Box 370, Orangeville, Utah 84537-0370 Phone 801 748-2140

4 With the loss of the 2nd South area the only place set up to mine is the 6th West panal.

5 The 6th west panal is now active and is mined two shifts per day (to make up produciton due to the loss of a continuous mining machine).

6 By mining the 6th West section two shifts per day, coal production in this section is now double and the section is advancing at twice the planned rate.

The projected mine plan for the ACT/015/009 permit area was designed to be able to mine the Tract 1 area until the end of 1987 and allow ample time for the Tract 2 area to be permitted. However, the above mentioned series of unplanned events have voided those earlier mine projections.

With production and quality quotas to meet and maintain, Trail Mountain Coal Company has been forced to make radical changes in our mine plan and at this time we are searching for any and all avenues available to maintain our present level of production and coal quality.

Had these conditions been identified prior to October 16, 1986 (the date of Trail Mountain Coal Company's first IBC submittal), a ten acre IBC would have been asked for at that time.

Enclosed is Trail Mountain Coal Company's submittal for a second IBC. Once again your review and consideration is greatly appreciated. If you have any questions or need further information, please feel free to contact me at (801) 748-2140.

Sincerely;

TRAIL MOUNTAIN COAL COMPANY

Allen P. Childs
Mine Engineer

Enclosures

APC/gg

# TRAIL MOUNTAIN COAL COMPANY
# INCIDENTAL BOUNDARY CHANGE
# SUBMITTAL

Prepared For:
Trail Mountain Coal Company
Orangeville, Utah

Prepared By:
Engineering Department

# INTRODUCTION

Trail Mountain Coal Company formally submits to the Division of Oil, Gas and Mining an application for a permit change using the Incidental Boundary Change criteria as adopted by the Board October 2, 1985 and as approved by O.S.M. January 16, 1986.

SMC/UMC 700.5 Definition - "Incidental Boundary Change" - Additions of deletions which result in a net increase to the originally approved permit area which are less than one (1) percent, or 10 acres, whichever is smaller.

Under permit number ACT/015/009 Trail Mountain Coal Company is the lessee of federal coal lease U-082996 containing 80 acres, the lessee of state coal lease ML-22603 containing 640 acres and the owner of certain fee-owned parcel containing 53.5 acres for a total lease holdings under permit ACT/015/009 of 773.5 acres.

Trail Mountain Coal Company is also the lessee of Federal Coal Lease U-09332 containing 641.47 acres and has filed with the Utah Division of Oil, Gas and Mining a permit application package with a tentative approval date of February 1, 1987. With this additional acreage, the total lease holdings of Trail Mountain Coal Company would total 1,414.97 acres.

On October 16, 1986, Trail Mountain Coal Company submitted to the Utah Division of Oil, Gas and Mining a permit amendment for an incidental boundary change to increase the ACT/015/009 permit area by six acres. On November 19, 1986, Trail

Mountain Coal Company received approval from the Utah Division of Oil, Gas and Mining for the six acre boundary change.

Under the incidental boundry change criteria, Trail Mountain Coal Company would request a second increase to our origingal approved permit of an additional four acres. (See Figure 3-6D).

This is Trail Mountain Coal Company's second request for an incidental boundary change (IBC) and is a cumulative total of ten acres which is the maximum acre criteria of UMC 700.5.

The requested four (4) acres would access a Federal Lease assigned to Trail Mountain Coal Company.

There is no surface disturbance associated with the requested four acres. There are no seeps, springs or ponds that would be affected by possible subsidence within or adjacent to the requested four acres.

The requested four acres are part of the corridor system to access Trail Mountain Coal Company's Tract 2 permit area (MRP on file).

The surface owner has been notified of Trail Mountain Coal Company's intention of accessing Tract 2 within the next six months. (see UMC 782.13 (E)).

UMC 782.13 - Identification of Interests

(A)(1) Permit Application

Trail Mountain Coal Company
P. O. Box 550
Orangeville, Utah 84537

(801) 748-2140

(A) (2) Owner of Records of Surface Area and of Coal Rights

Owner of record of the areas affected by surface operations:

Trail Mountain Coal Company
P. O. Box 550
Orangeville, Utah 84537

Incidental boundary change will involve no additional surface operations or disturbance.

Owners of record of the coal to be mined:

Trail Mountain Coal Company
P. O. Box 550
Orangeville, Utah 84537

UMC 782.13 A.3 - Holders of Lease Hold Interests in Surface Area and of Coal Rights

Surface Ownership

1. The United State of America
Surface Management Agent
U.S. Forest Service
Manti LaSal National Forest
599 West River Drive
Price, Utah, 84501.

Mineral Ownership

1. The United States of America
Surface Management Agent
The Department of the Interior
Bureau of Land Management, Moab District
P. O. Box AB
Price, Utah, 84501.

2. Trail Mountain Coal Company, Federal Coal Lease No. U-49332.

UMC 782.13 A.4 - Purchase of Record Under a Realestate Contract for Surface Area or Coal

None.

UMC 782.13 A.5 - Operator

The operator is the same as the applicant

Trail Mountain Coal Company
P. O. Box 550
Orangeville, Utah, 84537.

UMC 782.13 A.6 - Resident Agent

The resident agent who will accept services of process is:

CT Corporation System
170 South Main Street
Salt Lake City, Utah 84101

Telephone - (801) 364-1228

UMC 782.13 B - Business Designation

The applicant is a corporation.

UMC 782.13 B.1 - Officers and Directors of the Applicant

See Trail Mountain Coal Mine Tract 2 Permit Application package, Volume 1, Chapter 2, Page 5.

UMC 782.13 B.2 - Principle Shareholder of the Applicant

**Natomas Coal Company is the principle and only shareholder of the applicant.**

**Address:**

**Natomas Coal Company**
**1200 First Security Plaza**
**Lexington, Kentucky, 40507.**

UMC 782.13 B.3 - Names Under Which Applicant and Principle Shareholder Operated U.S. Coal Mines

**Mines operated within the previous five years are:**

**Trail Mountain Coal Company***
**P. O. Box 550**
**Orangeville, Utah, 84537.**

Federal I.D.

42-01211

State I.D.

ACT-015-009

Reclamation Permit No.

ACT-015-009

UMC 782.13 C - Principles, Officers, and Resident Agents

See Trail Mountain Coal Mine Tract 2 Mining and Reclamation Plan, Volume 1, Chapter 2, Page 7.

UMC 782.13 D - Current Pending or Previous Coal Mining Permits

See UMC 782.13 B,3.

UMC 782.13 E - Owner of Record of Surface and Subsurface Areas Contiguous to Proposed Permit Area

Surface

The United States of America
Surface Management Agent
The U.S. Forest Service
Manti LaSal National Forest
599 West River Drive
Price, Utah, 84501.

The United States of America
Surface Management Agent
The Department of the Interior
Bureau of Land Management, Moab District
P. O. Box AB
Price, Utah, 84501

Subsurface

The United States of America
Surface Management Agent
The Bureau of Land Management, Moab District
P. O. Box AB
Price, Utah 84501

UMC 782.13 F - Mine Name and MSHA Identification

Mine Name

Trail Mountain Mine

MSHA Identification Number

42-01211

UMC 782.13 G - Applicant's Interest in Areas Contiguous to Proposed Incidental Boundary Change Area

The applicant has assigned to them Federal Lease U-49332. This is a federal coal lease containing 641.47 acres that is contiguous to the proposed incidental boundary change area.

UMC 782.14 - Compliance Information

UMC 782.14 1 - Status of Mining Permits or Bonds

No federal or state mining permits have been suspended or revoked during the history of the mine. No bonds of security have been forfeited during the history of the mine.

UMC 782.14 C - Mine Activity Violations

See Trail Mountain Coal Company, Trail Mountain Mine Tract 2 Mine and Reclamation Plan, Volume 1, Chapter 2, Pages 11 through 13.

UMC 782.15 - Right of Entry and Operation Information

Trail Mountain Coal Company bases its legal right to enter and begin undergound coal activities on the incidental boundary change criteria. Also Trail Mountain Coal Company will be entering into Federal Lease No. U-49332, which is a federal coal lease all ready assigned to Trail Mountain Coal Company. See Trail Mountain Coal Company Tract 2 Mine and Reclamation Plan.

UMC 782.16 - Relationship to Areas Designated Unsuitable for Mining

The proposed four acres of the incidental boundary change is not within an area designated unsuitable for the surface effects of underground coal mine activities under UMC 764. Neither is the proposed four acres under study for designated for an administrative proceeding initiated under those parts. Mining would not affect renewable resource lands and would not result in substantial loss of food, fiber or water supply. The four acres contains no prime farm land or merchantable timber. Mining would not affect natural hazard lands and thereby endanger life and property. The proposed four acres includes no cemetaries, no natural trails, no wild and scenic rivers, no wilderness or wilderness study areas. There are no seeps or springs found within the proposed area.

UMC 783 - Requirements for Information on Environmental Resources

See ACT/015/009 MRP Chapters 3-12

Tract 2 MRP Chapters 3-12

UMC - 784 - Requirements for Reclamation and Operation Plan

See ACT/015/009 MRP and Tract 2 MRP Chapter 3 for operation paln to be used in the requested four acres.

There will be no recalmation associated with the requested four acres.

UMC 785 - Special Categories of Mining

UMC 785 does not apply to the requested four acres.

# APPENDIX 1-2

# NEWSPAPER ADVERTISEMENTS

## APPENDIX 1-2

## Newspaper Advertisements

# CHAPTER 2

# SOILS

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Yellow highlight signifies Text/Information Previously in Approved DOGM Permit, Moved and incorporated into Chapter 2 from previous Chapters 8 and 9). Red text within the yellow highlight is revised text. The un-highlighted text is new information being added to the permit document.

# CHAPTER 2
# SOILS

## 200 Minimum Requirements for Information on Soil Resources

### 210 Introduction

The Mine is a previously disturbed site, having been in operation since l948. As such, no pre-mining conservation or reclamation measures were taken and little stockpiling of soil from areas to be disturbed were done. Likewise, no pre-mining studies were conducted in the disturbed area. Accordingly, future reclamation plans will have to rely on existing soil to provide a suitable medium in which to establish new vegetation. Fossil Rock has leased the Cottonwood Lease, although this lease will not be mined until permitted baseline information associated with the lease is provided in this chapter.

### 211 Description of Pre-mining Soil Resources

The existing disturbed site has been compacted by heavy equipment and automobiles. Some sections have also been subjected to years of oil, gasoline, and diesel fuel spillage. Moreover, coal piles have existed at the site, causing crushed coal and coal dust to be mixed and compacted into the existing soil.

The soils in the disturbed area support a streamside plant community of dominant narrow leaf cottonwood trees plus lesser numbers of Rocky Mountain Juniper, Chokecherry, Elderberry, and numerous understory species of shrubs, grasses, and forbs. The transition zone on the same soil, but away from the stream and not yet on the steep Pinion-Juniper covered canyon slopes, has more juniper and pinion pine and is more open. The understory is mostly grasses and sagebrush.

The area is useful mainly for wildlife, recreation, limited grazing and mining. No cultivation could be established because of the steepness of the canyon.

Selected text in this section was obtained from the Cottonwood Canyon Tract Environmental Impact Statement (EIS), Appendix 2-1.

Soils overlying mountain side slopes and associated landforms are developing in limestone, sandstone, and shale parent materials. These soils occur on slopes ranging from 5 to 80 percent and are typically moderately deep to very deep, well to somewhat excessively drained, and have "moderate" available water capacities. The erosion hazard ranges from "low" to "high" but is typically "moderate" to "high" for the majority of these soils. Soil textures are highly variable ranging from loams to very cobbly loams for surface soils and from sandy loams to extremely stony clay loams for subsurface soil horizons. Coarse fragment contents (by volume) are similarly variable ranging from less than 15 to 40 percent and from less than 15 to 70 percent for surface and subsurface soils, respectively. The pH values of these soils are typically above 6.5 to 7.0, though values as low as 5.6 occur infrequently. The primary limitations to map unit revegetation include steep slopes and slope instability.

Sandstone and shale parent materials overlying slopes ranging from 20 to 80 percent dominate the canyon, escarpment, and associated landform soils of the lease area. These soils are shallow to very deep, well drained, and typically exhibit "moderate" available water capacities. Erosion hazards are rated as "moderate" to "high." Textures range from sandy loams and loams to very stony loams throughout the profile. Coarse fragment contents of surface soil horizons are typically less than 25 to 30 percent while subsurface horizons commonly exhibit percentages exceeding 50 percent. The pH values of these soils range from 5.2 to 9.0, though values above 7.0 predominate. Steep slopes and droughty soils are the major constraints to revegetation of these units.

Soils overlying ridges and associated mountainsides are forming in limestone, shale, and sandstone parent materials on slopes ranging from 5 to 60 percent. The depth, drainage, and available water capacity characteristics of these soils are similar to those overlying canyon and escarpment landforms. Erosion hazards vary from "low" to "high". Surface soil textures range from loams and clay loams to gravelly loams with coarse fragment contents rarely exceeding 25 percent. Subsoil textures range from clay loams to very cobbly clay loams with coarse

fragment contents highly variable. The pH values vary from 6.6 to 8.2. Steep slopes and shallow soils limit the revegetation potentials of these units.

Shallow to very deep, well drained soils with "low" to "moderate" available water capacities typify the ridges, benches, and plateaus of the lease area. Limestone and shale are the dominant parent materials underlying slopes ranging from 5 to 60 percent. The erosion hazards are typically rated as "low" to "moderate." Surface soil textures range from loams to gravelly sandy loams while subsoil textures range from gravelly clay loams to extremely stony clays. Coarse fragment contents vary from less than 15 percent to 65 percent throughout the profile. The pH values range from 6.4 to 8.3. Constraints limiting the revegetation potentials of these units variably include high surficial coarse fragment cover, high lime content, clayey subsoils, and steep slopes.

Soils overlying valley bottoms and fans are developing in mixed alluvial and colluvial parent materials. These soils occur on slopes of 30 percent or less and are typically very deep and well drained with "moderate" to "high" available water capacities. The erosion hazard ranges from "low" to "moderate." Soil textures typically range from sandy clay loams and loams to very cobbly clay loams with coarse fragment contents typically ranging from less than 15 to 60 percent, increasing with depth. The pH values of these soils typically exceed 7.8. The main limitation to map unit revegetation is the potential for droughty soil conditions.

No prime farmland soils occur within the lease area.

### 212 Topsoil Handling

Topsoil salvaged in the future will be placed in a stockpile. Topsoil stockpiles will be constructed to reduce erosion of the stockpiles by either wind or water. The topsoil stockpiles will be located on stable surfaces where they will not be disturbed by the mining operation. Topsoil stockpiles will be seeded as soon as practical and berms will be constructed around the base of stockpiles where necessary to prevent loss of topsoil material from the stockpiles. Revegetation test plots were previously set up to determine the suitability of the existing disturbed soil as a growth medium. (see Vegetation Test Plots, Appendix 3-9-2). Soil sample data is also included in Appendices 3-9-1 and 3-9-2, along with the vegetation test plot data.

Supplemental soil may be required for future reclamation, and because the mining property to be

reclaimed was already disturbed, it was necessary to characterize the soil from adjacent reference areas. These were chosen in two locations; as near as possible to the disturbed area and in areas determined, as well as could be done, to correspond in both soil type and vegetative community type to that of the disturbed area. Refer to Section 222 for additional information.

## 220 Environmental Description

### 221 Prime Farmland Investigation

Lands on which surface coal mining and reclamation operations were conducted prior to August 3, 1977 are exempt from prime farmland investigations. The mine site was disturbed prior to August 3, 1977; thus, the pre-disturbed area would not have been classified prime farmland. Addition information is provided in Section 211. A negative prime farmland determination is presented in Appendix 4.3.

### 222 Soil Survey

Selected text and tables in this section were obtained from the Cottonwood Canyon Tract Environmental Impact Statement (EIS), Appendix 2-1.

An Order III soil survey was completed for the Manti-La Sal National Forest and a draft report prepared in 1995 (Larsen, 1995). The report consisted primarily of soil map unit descriptions, typical pedon descriptions, interpretive data, and a survey map depicting map unit boundaries at a scale of 1:24,000. The report was reviewed by agency personnel, revisions made, and a second draft report issued containing updated soil information. The second report, *Soil Resource Inventory of the Manti Division Manti-La Sal National Forest, Utah* (Larsen, 1997), was used herein to describe the soils overlying the lease area and to assess the potential impacts to the soil resource. No site-specific soil baseline studies were conducted for the Cottonwood lease area as a part of this project.

To initiate this project, existing soil survey information was requested from various sources. A contact was made with a representative of the Natural Resources Conservation Service (NRCS) (Sasser, 1998) to determine whether this agency had conducted any soil surveys within the lease area. Given that the entire lease area is managed by the USDA, Forest Service, no surveys had been performed by the NRCS. Concurrently, the document titled *Cottonwood Canyon Tract Lease-By-Application No. 8 (UTU-68012)* (PacifiCorp/ Energy West Mining Company, 1997) It

was found that this document contained soils information for only a portion of the proposed lease area. Additional soils information (the baseline soil survey from which the Applicant had developed the lease area report cited above) for the entire lease area was obtained from the Manti-La Sal National Forest. A copy of the revised baseline soil survey (Larsen, 1997), including a soil map of the proposed lease area, was used in this analysis.

The proposed development plans for the lease area were reviewed to assess, initially, the potential impacts to the soils of the project area. The proposal includes construction of two ventilation shafts and 16 drill pads. No new road construction is planned though small road spurs may be necessary to access some drill pads. Given this limited level of proposed disturbance, it was determined that the main issues with respect to the soils discipline would include the potential for slope failures at escarpment formations and other steeply sloping areas, as well as potential subsidence. The revegetation potentials of the soils to be disturbed would also be of concern with respect to decreasing soil erosion and site stabilization potentials.

A total of 15 soil map units, characterized by 23 soil families and four miscellaneous groupings, were delineated within the lease area at the Order III level (Larsen, 1997). These soils are forming in response to the wide variety of parent materials, elevations, slopes, aspects, and rates of material weathering common to the lease area. Consequently, these soils exhibit a wide variety of characteristics in terms of soil chemical and physical properties. Plate 2-1, Soils, depicts the 15 soil map units delineated. Table 2-1, Soil Characteristics Summary, presents edaphic data for selected parameters having a bearing on the salvage suitability of the dominant soils mapped as well as erosion hazard ratings assigned and primary limitations to map unit revegetation.

Soils Identification and Descriptions - Four main soil types occur in the mine plan area, plus various thin soils among rocky outcrops and on talus slopes, which are designated as rockland (map symbols RoG and RY). Two of the four developed soil types are dry stony soils of steep mountain slopes. These are designated by the map symbols AbG (Very stony sandy loam complex) and CoG (Stony sandy loam complex). A third soil type, designated SN (shaly colluvial land), is located on the top of Trail Mountain in areas that will not be disturbed by mining activities and therefore will not be considered further. The fourth soil type, here designated by the map symbol R (for Riparian), is the principal soil type found in the disturbed area. In the soil pit located north of the Mine disturbed area, it would be classified as an azonal soil or entisol, and probably an arent (from ar, L., to plow, meaning mixed horizons). However, the soil is also located within a

mapping unit called the Kenilworth Series, which is also defined as a Xerollic Calciorthid Ardidisol.

Kenilworth Series, which is also defined as a Xerollic Calciorthid Ardidisol is the soil of the canyon bottom along the stream. It is characterized by numerous gravelly, silty, and sandy layers; but in the Reference Area it does not exhibit any soil profile development. It is in alluvial soil that has developed from gravelly outwash brought down by the canyon stream during infrequent floods plus collected finer fractions deposited by wind and talus erosion. It is a deep soil, exceeding 5 feet and often attaining l0 or more feet, as may be seen at some eroded banks along Cottonwood Creek. The soil pit dug in the Riparian Community reference area showed eight horizons (but no classic soil profile) including what appeared to be a buried soil profile from an earlier time.

The streamside, or canyon-bottom soils were referred to as the Kenilworth Series in a prior classification (USDA, USDI, and UAES, l970), specifically to the KeE2 mapping unit. This was called the Kenilworth very stony sandy loam of 0 to 20 percent slopes. This soil is stony, well-drained, and moderately coarse textured. In its broader distribution, this soil type occupies high benches on old dissected outwash plains below very steep mountains. It forms in thick deposits of strongly calcareous (high lime) stony alluvium and supports a vegetative cover mostly of juniper and pinion. The land use is mainly for wildlife, recreation, and limited grazing.

In Cottonwood Canyon, at the site of the Mine plan area, the presence of the canyon stream has led to a well-developed streamside plant community of narrow leaf cottonwood trees and a lush understory of grasses and forbs. This community is narrowly distributed along the stream course. Higher up, it transitions into the Pinion-Juniper Community of the east-facing steep slopes of Trail Mountain. Probably 25% or less of the ~~Trail Mountain~~ Mine disturbed area is located on soils of this canyon-bottom type within the Riparian Plant Community and its transition zone away from the stream, but still in the canyon bottom.

Three of the above four soils that were found in the approved Mine Plan were also found on the Tract 2 Mine Plan Area. They were RoG (rocklands), CoG (stony sandy loam complex), and AbG (very stony sandy loam complex).

In addition, five other soil types were found within the boundaries of the Tract 2 Mine Plan Area (data taken from the Soil Conservation Service and U.S. Forest Service, Price, Utah). The map

symbols and soil types are: ACl (Argic Pachic Cryoborolls), TU (Typic Ustorthents), TC (Typic Cryorthents), AC3 (Argic Pachic Cryoborolls), and AC2 (Argic Pachic Cryoborolls). These soils are also located in areas that will be undisturbed by mining, and therefore will not be considered further.

### 222.100 Soils Map

The soils are presented on Plate 2-1.

### 222.200 Soil Identification

Soil identifications are presented in Section 222.

### 222.300 Soil Description

Soil descriptions are presented in Section 222.

### 222.400 Soil Productivity

The Soil Conservation Service estimated productivity for the Riparian Community to be 2500 lbs/acre and the Grassland Shrub Community to be 900 to 1000 lbs/acre. (See Appendix 3-9-1).

## 223 Prime Farmland Soil Characterization

Refer to Section 221.

## 224 Substitute Topsoil

Topsoil resources were not protected during development activities from 1948 to 1967. Little soil exists on the presently disturbed mine site. What soil existed prior to commencement of mining activities has long been buried by construction of the pads and buildings. With special handling, the disturbed land fill should provide a suitable seed bed for revegetation. Special

handling will include removal of contaminated material and large coarse rock fragments (greater than 18 inches). The large rock fragments will be used as rip-rap in channel restoration, buried with the fill, or randomly placed on the reclaimed surface. Coal/refuse will be hauled to the Cottonwood Waste Rock Site for disposal.

Contaminated soil material which contains greater than 50 percent coal fines, will be disposed of at the Cottonwood Waste Rock Site. As determined by visual inspection, soil contaminated with oil and grease will be disposed of at an approved site. The volume of such material cannot be accurately estimated; however, it will likely be less than two percent of total volume.

There are no acid-or toxic-forming materials known to exist at this site. If discovered acid-or toxic-forming materials will be disposed of on-site and covered with 4' of material or removed to the Cottonwood Waste Rock Site.

Pad areas will be ripped for 12 to 24 inches to loosen the fill profile using the rippers on the dozer. Once backfilled and graded, the surface will be scarified with the teeth on the backhoe or using the tracks of the dozer to create "pockets" for water retention and root penetration. Soil samples will be taken to identify the need for replenishment of various soil nutrients, as described below in “Post-grading Soil Sampling”.

**Soil Test Pits -** The soils in the disturbed area were investigated by digging two soil pits. The results of textural analysis from the Riparian Reference Area soil pit are shown in Table 2-3. Chemical tests are shown in Table 2-4.

Soil mapping unit R1 - The top layer, which is not necessarily an A horizon, is 9 to 10 inches thick and is mainly a sandy clay loam texture having only about 5% rock over 2 mm diameter and 95% fine soil particles. The finer soil fraction is 48% sand, 30% silt, and 22% clay. Deeper layers show increasing percentages of rock (mainly gravel) down to layer 5, which suddenly reverts to less than one percent rock. This layer is also thick (7 inches) suggesting an older soil A horizon buried by the present developing soil surface.

Table 2-4 shows pH values ranging from 8.0 to 8.4 and slight salinity at the surface, increasing with depth. It is highly calcareous soil, with an average phosphorus content of p = 2.0 ppm and a

potassium content of K = 217 ppm by the standard soil fertility test.

The second soil pit was located in the Grassland Shrub Community on a steep northeast facing slope uphill from the coal loading piles of the disturbed area. This is the mapping unit CoG or RoG. It is a soil type that has been disturbed by the Mine operations, but only slightly. Some of the lower steep hillside has been cut away to provide clean mine entrances and room for a coal pile. About 75% or more of the disturbed area is represented by this soil type.

The results of textural analysis are shown in Table 2-5 and of chemical analysis in Table 2-6. The Grassland Shrub soil was relatively shallow, bedrock being encountered at only 19 inches. The A horizon was 5 inches deep and consisted of 71.5% fine soil and 28.5% larger rock fragments by weight. The fine soil fraction was a loam soil of 40.2% sand, 35.2% silt, and 24.6% clay. Deeper layers increased rapidly in rocky material, silt, and clay fractions. The pH ranged from 8.2 to 8.7 and the salinity from 0.3 to 0.4 mmhos/cm. Phosphorus and potassium levels were much lower than the streamside soil of the canyon bottom.

Soil textural analysis was performed in the lab using the Boyoucos hydrometer method with 50 gram samples. A sample of each soil horizon was sent to the Utah State University's Soil and Water Testing Laboratory in Logan, Utah for selected chemical analyses. These analyses included a standard fertility test (pH, salinity by probe, phosphorus, potassium, texture, and lime); exchangeable cation percentage (CEC, Na, K, Ca, and Mg, extractable ion, saturation percent, and the water soluble ions listed above); and sodium absorption ratios (SAR) where the salinity was found to be high.

Post-Grading Soil Sampling - The following text is from Appendix 2-8-3, Attachment C. Soil sampling will be conducted at the time of final reclamation after earthmoving and recontouring procedures and prior to the seedbed preparation techniques (see Appendix 3-9-1 for more on reclamation and revegetation techniques).

Sampling Design - Soil sample locations will be determined by a grid sampling design, placed at regular intervals on the grid. Distance between sample locations will be no more than 200 feet over the disturbed area. At each sample grid location two (2) composite soil samples will be collected: one sample from the top 12 inches and one sample from the underlying 36 inches.

Each sample will then be analyzed at a soil laboratory for their EC values. To determine suitability for use the top 12 inches of the growth media needs to have EC values of 8 mmhos/cm (or less) and the underlying 36 inches of soils needs to have values less than 16 mmhos/cm. A subset of 10-20 of these samples will be randomly picked and be analyzed for fertility. As determined necessary, soil nutrients and amendments will be applied to the redistributed soil to establish the vegetative cover.

In 1984, test plots were installed just north of the bathhouse at the Mine site. The results of the test plot sampling were encouraging for the use of surficial materials as topsoil. (See Vegetation Test Plots, Appendix 3-9-2). Soil sample data are included in Appendices 3-9-1and 3-9-2, along with the vegetation test plot data. The test plots were destroyed when the new bathhouse was constructed in 1990.

Certification of Reclamation Topsoil Suitability **-** The suitability of the substitute topsoil shall be certified by an approved laboratory in accordance with "UDOGM Guidelines for Management of Topsoil and Overburden, Table 1, 2, 3 & 7". Only the substitute topsoil used in lieu of, or in conjunction with on-site overburden and topsoil will be tested.

## 230 Operation Plan

### 232 Topsoil and Subsoil Removal

The mine was operational before the 1979 State Act or the 1977 Federal Act. Having been constructed prior to the requirement to save and stockpile topsoil, the soils on the site were used in construction of the roads and pads and buildings. The remaining surficial materials are being compacted and mixed with crushed coal and coal fines. Operation and maintenance of equipment contributes oil, gasoline and diesel fuel to the soil in some places.

Table 2-2, Surficial Salvage Depths, presents the depths to which soils of the disturbed area are suitable for salvage. These depths were selected considering the limited disturbances proposed while assuming that the unsalvaged subsoils remain in place and would be available as a subgrade growth medium following facility decommissioning. Map unit slopes were not considered since the range of slopes within a map unit often includes slope angles both accessible and inaccessible to salvage equipment.

A single depth or a depth range is presented for each map unit component depending upon subsoil characteristics. A depth range is indicative of transitional subsoils which would allow a deeper salvage depth considering the potential for soil blending during salvage. Limitations to deeper salvage are also presented for each map unit component, as is descriptive information regarding soil map unit component landscape positions (Larsen, 1997).

The soils overlying the project area exhibit a comparatively narrow range of characteristics with respect to salvage suitability. Proposed total salvage depths typically range from 6 to 18 inches and include both surface and subsurface soil materials. The main constraint to deeper soil salvage across the lease area is high subsoil coarse fragment content (>35% by volume). Low pH values (<6.5), clayey subsoils, high free lime contents, and shallow depths to bedrock also constrain salvage depth for several units. Refer to Section 224 for additional information.

Cottonwood Creek Culvert - A post-law borrow pit was utilized on site to obtain fill material for the 66" culvert for Cottonwood Creek. Topsoil was salvaged from the pit area and is stockpiled in a protected area just northwest of the intake portal for the mine. The pile has been revegetated and is further protected by installation of a silt fence around the bottom end. Please refer to Appendix 2-8-1 for details on the borrow area.
During the 1990 expansion of the disturbed area (0.471 acres) associated with the extension of the culvert (Appendix 7-13). Topsoil was removed and placed on an existing top soil storage pile and salvageable material at vegetation test plot location (at least the top 12") would be removed from and placed on the topsoil pile. It was estimated that an average depth of 16" of topsoil could be salvaged over 50% of the area of the culvert expansion resulting in approximately 200 cubic yards of topsoil.

Map A in Appendix 3-9-1 shows 13 vegetation test plots in the vicinity of the culvert expansion and subsequent parking lot expansion. The area was estimated to be 100' X 150' and if 12" was salvaged that calculates to 555.5 cubic yards. The new ventilation portal constructed during the same year was in a previously disturbed area (approximately the 1940's, Appendix 5-3-7) thus no topsoil was salvaged.

The borrow area (Appendix 2-8-1) used in the construction of the culvert expansion, etc. was from a pre-disturbed area, some topsoil was salvaged but the amount is not specified. By researching the existing information in the permit, it is estimated that there is 755.5 cubic yards of topsoil in the

existing topsoil pile. Surveying and topography for the pre-mined site is inadequate and was not used to estimate the topsoil in the pile. By measuring the stockpile area shown on Plate 3-7 the Applicant estimates the topsoil stockpile area to be 2322 square feet, in conjunction with the other information provided above the topsoil is approximately 8.6 feet deep in the stockpile.

The methods described are followed when removing and storing soil resources that necessitate removal as a result of construction to facilitate new surface operations. Soil salvage will take place in two lifts where possible. The first lift layer will include the A horizon material to be stockpiled in one location and the second lift will include the remaining B and C horizons. B and C horizons would be stockpiled in a second adjacent location. These stockpiles will be graded to gradual slopes (2h:1v to 3h:1v) and seeded to promote surface stabilization.

Where topsoil thicknesses of less than 6 inches are encountered, the topsoil and underlying unconsolidated materials (up to 6 inches total) will be removed and stockpiled together; the entire mixture will be treated as topsoil in compliance with R645-201-234.300.

Where possible, soil removal will take place after vegetation has been removed that could interfere with soil salvage. Topsoil will not be handled when saturated either during the initial stripping, spreading or final grading.

### 233 Topsoil Substitutes and Supplements

See Section 224.

### 234 Topsoil Storage

Topsoil stockpiles shall be placed on a stable site. Stockpiled topsoil will not be moved until redistributed during reclamation operations unless approved by the UDOGM. The piles will be protected from contaminants and unnecessary compaction that would interfere with revegetation. Topsoil stockpiles are protected by the establishment of a vegetative cover.

## 240 Reclamation Plan

### 242 Soil Redistribution

Once the buildings, mine equipment, coal piles and other structures and disturbances are removed, the existing disturbed area will be graded to the final configuration. If the existing soil is unsuitable for revegetation and supplemental soil is brought in, a depth of not less than six inches should then be applied and graded in preparation for seeding. Existing soil should prove adequate for plant growth. Refer to Sections 542 and 553 for Backfilling and Grading Plan.

Soil Thickness. Topsoil will be distributed on areas with slopes less than 1h:1.5v that are to be reclaimed. Topsoil redistribution procedures will ensure an approximate thickness of six inches.

Compaction. To prevent compaction of topsoil, soil moving equipment will refrain from unnecessary operation over spread topsoil. Front-end loaders and other wheel mounted equipment may be used to transport and dump topsoil. However, to minimize compaction, track-mounted equipment will be used to spread the topsoil. The topsoil will be disked or ripped, surface roughened, pitted, and/or deep gouged prior to seeding to help alleviate soil compaction, increase soil stability, and to increase water harvesting.

Erosion. Erosion control measures will include surface roughing, pitting, and deep gouging.

### 243 Soil Nutrients and Amendments

Existing soil or soils hauled in for the restoration of the disturbed soils may be supplemented with commercial fertilizers containing nitrogen, phosphorus, and potassium. The exact mixture and broadcast rate will have to be determined following tests on the soil used, refer to Section 224 for additional information.

### 244 Soil Stabilization

Reclaimed soil areas will be stabilized to control erosion by application of mulch and regarding of rills and gullies. Erosion control mats may be used if determined necessary to provide soil stabilization.

Rills and gullies that disrupt the reestablishment of vegetative cover or contribute to the degradation of stream quality will be regraded, the topsoil replaced, and reseeded.

### 250 Performance Standards

Topsoil, subsoil and topsoil substitutes or supplements will be removed, maintained and redistributed according to the plan given under R645-301-230 and R645-301-240.

## References

Larsen, D. M. 1995. Soil Survey of the Manti-La Sal National Forest; Manti Division, Utah (draft). USDA, Forest Service. Price, Utah. various pages, appendices and maps.

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Soil Survey Staff, Natural Resources Conservation Service. 1996. National Soil Survey Handbook, Title 430-VI. U.S. Government Printing Office. Washington, D. C. various pages.

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**Table 2-1**:
**Soil Characteristics Summary**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] |
|---|---|---|---|---|---|---|
| **Map Units of Mountain Sideslopes and Associated Landforms** | | | | | | |
| 8 (30-80) | | | | | | |
| Greyback (40) | Slopes & benches | Mod. deep | cosicl/vcosicl-xstcl | 30/70 | 7.6/7.5-7.8 | H |
| Cryorthents (20) | Slopes | Varies | sl-c/sl-c | 5-65 | Varies | H |
| Echard (20) | Slopes | Deep+ | sicl/c | <15/<15 | 7.5/7.6-7.7 | M |
| 25 (5-30) | | | | | | |
| Doney (30) | Slopes | Mod. deep | l-stl/l | <15-20/<15 | 8.4-8.6/8.6-9.0 | M |
| Allens Park (30) | Benches & slopes | Mod. deep | cl-scl/cl-coscl | <15/<15-30 | 7.8-8.0/8.0-8.3 | M |
| Repp (25) | Ridges & slopes | Mod .deep/deep | scl/vgrscl | <15/40-60 | 8.0/8.0 | M-H |
| 100 (30-70) | | | | | | |
| Gralic (40) | Ridges & slopes | Deep+ | grsl/vcosl | 20/50-55 | 6.4/6.7-8.0 | L-M |
| Behanin (25) | Slopes | Deep | l/vstl-xstcl | <15/55-65+ | 7.0/7.0-7.8 | M |
| Elwood (20) | Slopes | Deep+ | vstl-vcocl/xcol-vcosl | 35-40/25-60 | 6.4-6.6/6.0-6.2 | H |
| 560 (5-50) | | | | | | |
| Clayburn (45) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | M |
| Greyback(45) | Slopes | Mod. deep | cosicl/vcosicl-xstcl | 30/70 | 7.6/7.5-7.8 | M |
| 700 (30-80) | | | | | | |
| Pachic Cryoborolls (35) | Slopes | Deep | sic/grsic-vgrc | 5-15/30-55 | 7.2-7.5/7.4-7.9 | M-H |
| Typic Cryoborolls (25) | Slopes | Deep | cocl/vcocl-vcoc | 25-35/25-40 | 7.8/8.0 | M-H |
| 820 (30-70) | | | | | | |
| Lucky Star (50) | Slopes | Deep+ | l-col/vcosl-vcocl | 10-20/55-60 | 6.0-6.2/5.6-6.0 | M |
| Bundo (25) | Slopes | Deep + | grsl-vgrsl/vgrsl-xcoscl | 25/50-65 | 5.8-6.2/5.6-5.8 | M |
| Adel (20) | Short slopes | Deep+ | l/l-grsil | <15/<15 | 6.0/5.6-6.0 | H |

**Table 2-1**:
**Continued**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] |
|---|---|---|---|---|---|---|
| **Map Units of Canyon Slopes, Escarpments, and Associated Mountain Slopes** | | | | | | |
| 20 (30-80) | | | | | | |
| Strych(30) | Slopes | Deep+ | sl-grsl/vgr-vcosl | <15-25/50-55 | 8.2/8.4 | M-H |
| Pathead (30) | Slopes | Deep+ | col/vco-vstl | 30/45-60 | 7.2/7.2-8.4 | M-H |
| Podo (15) | Slopes & benches | Shallow | l-grsl | 10-25 | 8.2 | M-H |
| Rubbleland (15) | Slopes | Varies | Varies | Varies | Varies | Varies |
| 107 (20-70) | | | | | | |
| Scout (35) | Slopes | Deep+ | sl/sl-vgrsl | <15/<15-65 | 5.2/5.2-5.5 | H |
| Doney (25) | Slopes | Mod. deep | l-stl/l | <15-20/<15 | 8.4-8.6/8.6-9.0 | H |
| Guben (25) | Slopes & draws | Deep+ | sci-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | H |
| **Map Units of Ridges and Associated Mountainsides** | | | | | | |
| 23 (20-60) | | | | | | |
| Ridge (40) | Ridges | Shallow | grl-cl | <25 | No info. | H |
| Guben (30) | Slopes & fans | Deep+ | sci-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | H |
| Podo (20) | Slopes | Shallow | l-grsl | 10-25 | 8.2 | M-H |
| 561 (5-40) | | | | | | |
| Clayburn (55) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | L-M |
| Faim (20) | Ridges & slopes | Deep+ | cl/cl-c | <15/<15 | 6.6/6.8-8.2 | L-M |
| Behanin (15) | Slopes | Deep | l/vstl-xstcl | <15/55-65+ | 7.0/7.0-7.8 | L-M |
| **Map Units of Ridges, Benches,and Plateaus** | | | | | | |
| 24 (5-30) | | | | | | |
| Rabbitex (45) | Fans & slopes | Deep+ | l-cl/cl-grcl | <15/10-25 | 8.2-8.3/8.2-8.3 | H |
| Repp (33) | Ridges & slopes | Mod. deep/Deep | scl/vgrscl | <15/40-60 | 8.0/8.0 | M-H |
| 41 (2-15) | | | | | | |
| Castino (90) | Ridge tops | Mod. deep | cl/xstc | <15/65 | 7.0-7.2/6.8-7.6 | L |

**Table 2-1**:
**Continued**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] |
|---|---|---|---|---|---|---|
| **Map Units of Ridges, Benches,and Plateaus(Continued)** | | | | | | |
| 402 (8-60) | | | | | | |
| Roxal (40) | Ridgetops | Shallow | cl/cl | <15/20 | 6.8/6.8 | M |
| Merino (25) | Ridges & slopes | Shallow | vcol/vcol | 35/60 | 6.8/6.8 | M |
| Gralic (20) | Ridges & slopes | Deep+ | grsl/vcosl | 20/50-55 | 6.4/6.7-8.0 | L-M |
| 411 (5-30) | | | | | | |
| Clayburn (55) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | L-M |
| Faim (30) | Ridges & slopes | Deep+ | cl/cl-c | <15/<15 | 6.6/6.8-8.2 | M |
| **Map Units of Valley Bottoms and Fans** | | | | | | |
| 26 (0-30) | | | | | | |
| Gubin | Slopes & fans | Deep+ | scl-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | M |
| Rabbitex | Fans & slopes | Deep+ | l-cl/cl-grcl | <15/10-25 | 8.2-8.3/8.2-8.3 | L-M |

[1] Deep = 40-60+", Moderately deep = 20-40", Shallow = <20"
[4]2 Modifiers: gr = gravelly, vgr = very gravelly, exgr = extremely gravelly, co = cobbly, vco = very cobbly, exco = extremely cobbly, st = stony, vst = very stony, exst = extremely stony; textures: s = sand, ls = loamy sand, sl = sandy loam, l = loam, si = silt, sil = silt loam, scl = sandy clay loam, cl = clay loam, sicl = silty clay loam, sc = sandy clay, sic = silty clay, c = clay.
[3] L= Low; M = Moderate; H = High

**Table 2-2:**
**Surficial Salvage Depths**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Primary Surficial Salvage Depth (in.) | Primary Salvage Depth Limitation (s) |
|---|---|---|---|
| 8 (30-80) | | | |
| Greyback (40) | Slopes & benches | 12 | High coarse fragment content |
| Cryorthents (20) | Very steep slopes | Variable | Variable |
| Echard (20) | Slopes | 12 | Clay texture |
| 20 (30-80) | | | |
| Strych(30) | Canyon and escarpment slopes | 12 | High coarse fragment content, mod. high pH |
| Pathead (30) | Canyon slopes | 6-12 | High coarse fragment content |
| Podo (15) | Canyon slopes | 6-11 | Bedrock, high free lime content |
| Rubbleland (15) | Slopes | Opportunistic | High coarse fragment content, bedrock |
| 23 (20-60) | | | |
| Ridge (40) | Convex ridges | 11 | Bedrock |
| Guben (30) | Convex slopes & fans | 12-18 | High coarse fragment content |
| Podo (20) | Convex slopes | 6-11 | Bedrock, high free lime content |
| 24 (5-30) | | | |
| Rabbitex (45) | Convex or flat fans & slopes | 12 | High free lime content |
| Repp (33) | Convex slopes | 12 | High coarse fragment content |
| 25 (5-30) | | | |
| Doney (30) | Complex slopes | 12-18 | High free lime content, mod. high pH |
| Allens Park (30) | Complex benches & slopes | 12-20 | High free lime content, mod. high pH |
| Repp (25) | Complex slopes | 12 | High coarse fragment content |
| 26 (0-30) | | | |
| Gubin | Valley bottoms & fans | 12 | High coarse fragment content |
| Rabbitex | Valley bottoms & fans | 12 | High free lime content |
| 41 (2-15) | | | |
| Castino (90) | Convex slopes | 12 | High coarse fragment content |
| 100 (30-70) | | | |
| Gralic (40) | Long convex slopes | 6-12 | High coarse fragment content |
| Behanin (25) | Convex slopes | 12 | High coarse fragment content |
| Elwood (20) | Concave slopes | 12 | Low pH values, high co. frag. content |
| 107 (20-70) | | | |
| Scout (35) | North-facing slopes | 0 | Low pH values throughout profile |
| Doney (25) | Mountain slopes | 12-18 | High lime content, mod. high pH |
| Guben (25) | Mountain slopes & draws | 12 | High coarse fragment content |

**Table 2-2 (continued)**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Primary Surficial Salvage Depth (in.) | Primary Salvage Depth Limitation (s) |
|---|---|---|---|
| 402 (8-60) | | | |
| Roxal (40) | Convex ridgetops | 6-17 | Bedrock |
| Merino (25) | Convex ridges & slopes | 6-12 | Bedrock, High coarse fragment content |
| Gralic (20) | Slopes below ridgetops | 6-12 | High coarse fragment content |
| 411 (5-30) | | | |
| Clayburn (55) | Gentle to moderate slopes | 12-30 | High coarse fragment content |
| Faim (30) | Mountain slopes | 12-18 | Clay textures |
| 560 (5-50) | | | |
| Clayburn (45) | Short convex slopes | 12-30 | High coarse fragment content |
| Greyback(45) | Convex mountain slopes | 12 | High coarse fragment & free lime content |
| 561 (5-40) | | | |
| Clayburn (55) | Convex slopes | 12-30 | High coarse fragment content |
| Faim (20) | Concave slopes | 12-18 | Clay textures |
| Behanin (15) | Convex slopes | 12 | High coarse fragment content |
| 700 (30-80) | | | |
| Pachic Cryoborolls (35) | Mountain slopes | 12-18 | High coarse fragment content |
| Typic Cryoborolls (25) | Mountain slopes | 12 | High coarse fragment content |
| 820 (30-70) | | | |
| Lucky Star (50) | Mountain slopes | 6-12 | High coarse fragment content, low pH |
| Bundo (25) | Concave lopes | 6 | High coarse fragment content, low pH |
| Adel (20) | Short south-facing slopes | 12-24 | Low pH |

**Table 2-1:**
**Soil Characteristics Summary**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] |
|---|---|---|---|---|---|---|
| **Map Units of Mountain Sideslopes and Associated Landforms** | | | | | | |
| 8 (30-80) | | | | | | |
| Greyback (40) | Slopes & benches | Mod. deep | cosicl/vcosicl-xstcl | 30/70 | 7.6/7.5-7.8 | H |
| Cryorthents (20) | Slopes | Varies | sl-c/sl-c | 5-65 | Varies | H |
| Echard (20) | Slopes | Deep+ | sicl/c | <15/<15 | 7.5/7.6-7.7 | M |
| 25 (5-30) | | | | | | |
| Doney (30) | Slopes | Mod. deep | l-stl/l | <15-20/<15 | 8.4-8.6/8.6-9.0 | M |
| Allens Park (30) | Benches & slopes | Mod. deep | cl-scl/cl-cosci | <15/<15-30 | 7.8-8.0/8.0-8.3 | M |
| Repp (25) | Ridges & slopes | Mod .deep/deep | scl/vgrscl | <15/40-60 | 8.0/8.0 | M-H |
| 100 (30-70) | | | | | | |
| Gralic (40) | Ridges & slopes | Deep+ | grsl/vcosl | 20/50-55 | 6.4/6.7-8.0 | L-M |
| Behanin (25) | Slopes | Deep | l/vstl-xstcl | <15/55-65+ | 7.0/7.0-7.8 | M |
| Elwood (20) | Slopes | Deep+ | vstl-vcocl/xcol-vcosl | 35-40/25-60 | 6.4-6.6/6.0-6.2 | H |
| 560 (5-50) | | | | | | |
| Clayburn (45) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | M |
| Greyback(45) | Slopes | Mod. deep | cosicl/vcosicl-xstcl | 30/70 | 7.6/7.5-7.8 | M |
| 700 (30-80) | | | | | | |
| Pachic Cryoborolls (35) | Slopes | Deep | sic/grsic-vgrc | 5-15/30-55 | 7.2-7.5/7.4-7.9 | M-H |
| Typic Cryoborolls (25) | Slopes | Deep | cocl/vcocl-vcoc | 25-35/25-40 | 7.8/8.0 | M-H |
| 820 (30-70) | | | | | | |
| Lucky Star (50) | Slopes | Deep+ | l-col/vcosl-vcocl | 10-20/55-60 | 6.0-6.2/5.6-6.0 | M |
| Bundo (25) | Slopes | Deep + | grsl-vgrsl/vgrsl-xcoscl | 25/50-65 | 5.8-6.2/5.6-5.8 | M |
| Adel (20) | Short slopes | Deep+ | l/l-grsil | <15/<15 | 6.0/5.6-6.0 | H |

**Table 2-1:**
**Continued**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] |
|---|---|---|---|---|---|---|
| **Map Units of Canyon Slopes, Escarpments, and Associated Mountain Slopes** | | | | | | |
| 20 (30-80) | | | | | | |
| Strych(30) | Slopes | Deep+ | sl-grsl/vgr-vcosl | <15-25/50-55 | 8.2/8.4 | M-H |
| Pathead (30) | Slopes | Deep+ | col/vco-vstl | 30/45-60 | 7.2/7.2-8.4 | M-H |
| Podo (15) | Slopes & benches | Shallow | l-grsl | 10-25 | 8.2 | M-H |
| Rubbleland (15) | Slopes | Varies | Varies | Varies | Varies | Varies |
| 107 (20-70) | | | | | | |
| Scout (35) | Slopes | Deep+ | sl/sl-vgrsl | <15/<15-65 | 5.2/5.2-5.5 | H |
| Doney (25) | Slopes | Mod. deep | l-stl/l | <15-20/<15 | 8.4-8.6/8.6-9.0 | H |
| Guben (25) | Slopes & draws | Deep+ | sci-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | H |
| **Map Units of Ridges and Associated Mountainsides** | | | | | | |
| 23 (20-60) | | | | | | |
| Ridge (40) | Ridges | Shallow | grl-cl | <25 | No info. | H |
| Guben (30) | Slopes & fans | Deep+ | sci-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | H |
| Podo (20) | Slopes | Shallow | l-grsl | 10-25 | 8.2 | M-H |
| 561 (5-40) | | | | | | |
| Clayburn (55) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | L-M |
| Faim (20) | Ridges & slopes | Deep+ | cl/cl-c | <15/<15 | 6.6/6.8-8.2 | L-M |
| Behanin (15) | Slopes | Deep | l/vstl-xstcl | <15/55-65+ | 7.0/7.0-7.8 | L-M |
| **Map Units of Ridges, Benches,and Plateaus** | | | | | | |
| 24 (5-30) | | | | | | |
| Rabbitex (45) | Fans & slopes | Deep+ | l-cl/cl-grcl | <15/10-25 | 8.2-8.3/8.2-8.3 | H |
| Repp (33) | Ridges & slopes | Mod. deep/Deep | scl/vgrscl | <15/40-60 | 8.0/8.0 | M-H |
| 41 (2-15) | | | | | | |
| Castino (90) | Ridge tops | Mod. deep | cl/xstc | <15/65 | 7.0-7.2/6.8-7.6 | L |

**Table 2-1:**
**Continued**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] |
|---|---|---|---|---|---|---|
| **Map Units of Ridges, Benches,and Plateaus(Continued)** | | | | | | |
| 402 (8-60) | | | | | | |
| Roxal (40) | Ridgetops | Shallow | cl/cl | <15/20 | 6.8/6.8 | M |
| Merino (25) | Ridges & slopes | Shallow | vcol/vcol | 35/60 | 6.8/6.8 | M |
| Gralic (20) | Ridges & slopes | Deep+ | grsl/vcosl | 20/50-55 | 6.4/6.7-8.0 | L-M |
| 411 (5-30) | | | | | | |
| Clayburn (55) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | L-M |
| Faim (30) | Ridges & slopes | Deep+ | cl/cl-c | <15/<15 | 6.6/6.8-8.2 | M |
| **Map Units of Valley Bottoms and Fans** | | | | | | |
| 26 (0-30) | | | | | | |
| Gubin | Slopes & fans | Deep+ | scl-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | M |
| Rabbitex | Fans & slopes | Deep+ | l-cl/cl-grcl | <15/10-25 | 8.2-8.3/8.2-8.3 | L-M |

[1] Deep = 40-60+", Moderately deep = 20-40", Shallow = <20"
[4]2 Modifiers: gr = gravelly, vgr = very gravelly, exgr = extremely gravelly, co = cobbly, vco = very cobbly, exco = extremely cobbly, st = stony, vst = very stony, exst = extremely stony; textures: s = sand, ls = loamy sand, sl = sandy loam, l = loam, si = silt, sil = silt loam, scl = sandy clay loam, cl = clay loam, sicl = silty clay loam, sc = sandy clay, sic = silty clay, c = clay.
[3] L= Low; M = Moderate; H = High

## Table 2-2:
## Surficial Salvage Depths

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Primary Surficial Salvage Depth (in.) | Primary Salvage Depth Limitation (s) |
|---|---|---|---|
| 8 (30-80) | | | |
| Greyback (40) | Slopes & benches | 12 | High coarse fragment content |
| Cryorthents (20) | Very steep slopes | Variable | Variable |
| Echard (20) | Slopes | 12 | Clay texture |
| 20 (30-80) | | | |
| Strych(30) | Canyon and escarpment slopes | 12 | High coarse fragment content, mod. high pH |
| Pathead (30) | Canyon slopes | 6-12 | High coarse fragment content |
| Podo (15) | Canyon slopes | 6-11 | Bedrock, high free lime content |
| Rubbleland (15) | Slopes | Opportunistic | High coarse fragment content, bedrock |
| 23 (20-60) | | | |
| Ridge (40) | Convex ridges | 11 | Bedrock |
| Guben (30) | Convex slopes & fans | 12-18 | High coarse fragment content |
| Podo (20) | Convex slopes | 6-11 | Bedrock, high free lime content |
| 24 (5-30) | | | |
| Rabbitex (45) | Convex or flat fans & slopes | 12 | High free lime content |
| Repp (33) | Convex slopes | 12 | High coarse fragment content |
| 25 (5-30) | | | |
| Doney (30) | Complex slopes | 12-18 | High free lime content, mod. high pH |
| Allens Park (30) | Complex benches & slopes | 12-20 | High free lime content, mod. high pH |
| Repp (25) | Complex slopes | 12 | High coarse fragment content |
| 26 (0-30) | | | |
| Gubin | Valley bottoms & fans | 12 | High coarse fragment content |
| Rabbitex | Valley bottoms & fans | 12 | High free lime content |
| 41 (2-15) | | | |
| Castino (90) | Convex slopes | 12 | High coarse fragment content |
| 100 (30-70) | | | |
| Gralic (40) | Long convex slopes | 6-12 | High coarse fragment content |
| Behanin (25) | Convex slopes | 12 | High coarse fragment content |
| Elwood (20) | Concave slopes | 12 | Low pH values, high co. frag. content |
| 107 (20-70) | | | |
| Scout (35) | North-facing slopes | 0 | Low pH values throughout profile |
| Doney (25) | Mountain slopes | 12-18 | High lime content, mod. high pH |
| Guben (25) | Mountain slopes & draws | 12 | High coarse fragment content |

**Table 2-2 (continued)**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Primary Surficial Salvage Depth (in.) | Primary Salvage Depth Limitation (s) |
|---|---|---|---|
| 402 (8-60) | | | |
| Roxal (40) | Convex ridgetops | 6-17 | Bedrock |
| Merino (25) | Convex ridges & slopes | 6-12 | Bedrock, High coarse fragment content |
| Gralic (20) | Slopes below ridgetops | 6-12 | High coarse fragment content |
| 411 (5-30) | | | |
| Clayburn (55) | Gentle to moderate slopes | 12-30 | High coarse fragment content |
| Faim (30) | Mountain slopes | 12-18 | Clay textures |
| 560 (5-50) | | | |
| Clayburn (45) | Short convex slopes | 12-30 | High coarse fragment content |
| Greyback(45) | Convex mountain slopes | 12 | High coarse fragment & free lime content |
| 561 (5-40) | | | |
| Clayburn (55) | Convex slopes | 12-30 | High coarse fragment content |
| Faim (20) | Concave slopes | 12-18 | Clay textures |
| Behanin (15) | Convex slopes | 12 | High coarse fragment content |
| 700 (30-80) | | | |
| Pachic Cryoborolls (35) | Mountain slopes | 12-18 | High coarse fragment content |
| Typic Cryoborolls (25) | Mountain slopes | 12 | High coarse fragment content |
| 820 (30-70) | | | |
| Lucky Star (50) | Mountain slopes | 6-12 | High coarse fragment content, low pH |
| Bundo (25) | Concave lopes | 6 | High coarse fragment content, low pH |
| Adel (20) | Short south-facing slopes | 12-24 | Low pH |

PacifiCorp
Trail Mountain Mine

**Table 2-3**

**TABLE 8-1**
**RIPARIAN SOIL TEXTURAL ANALYSIS**

| | Horizons | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Thickness (cm) | 24 | 9 | 5 | 8 | 18 | 26 | 12 | 50 |
| Color | Light gray-brown | Light brown | Bluish-black | Light Brown | Blue-black | Grayish-yellowish-brown | Light yellowish-brown | Grayish-brown |
| Structure | Blocky-platy | None | Blocky | None | Blocky | Platy | None | Blocky |

**Weight Percents of Bulk Soil**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| % Rock > 2mm* | 4.80% | 36.00% | 20.50% | 50.10% | 0.80% | 2.00% | 55.00% | 13.00% |
| % Soil < 2mm | 95.20% | 64.00% | 79.50% | 49.90% | 99.20% | 98.00% | 45.00% | 87.00% |

**Weight Percents of Soil Fractions < 2mm**

"Old Method" (2nd Hydrometer Reading at 1 Hour)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| % Sand | 47.80% | 68.60% | 51.40% | 77.00% | 43.40% | 38.80% | 65.20% | 49.40% |
| % Silt | 29.80% | 16.80% | 28.50% | 11.80% | 33.80% | 36.40% | 17.20% | 27.20% |
| % Clay | 22.40% | 14.60% | 20.10% | 11.20% | 22.80% | 24.80% | 17.60% | 23.40% |
| Texture Class | Sandy Clay Loam | Sandy Loam | Sandy Clay Loam | Sandy Loam | Loam | Loam | Sandy Loam | Sandy Clay Loam |

"New Method" (2nd Hydrometer Reading at 2 Hours)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| % Sand | 47.80% | 68.60% | 51.40% | 77.00% | 43.40% | 38.80% | 65.20% | 49.40% |
| % Silt | 33.60% | 18.60% | 32.00% | 13.00% | 38.40% | 38.20% | 19.80% | 30.20% |
| % Clay | 18.60% | 12.80% | 16.60% | 10.00% | 18.20% | 23.00% | 15.00% | 20.40% |
| Texture Class | Loam | Sandy Loam | Loam | Sandy Loam | Loam | Loam | Sandy Loam | Loam |

* Tyler Screen, #10 mesh = 1.981 mm openings

**Table 2-4**

**TABLE 8-2**
**SOIL CHEMISTRY: RIPARIAN REFERENCE AREA**

| Horizon | Depth (cm) | Soil Texture Class | Acidity (pH) | Salinity (mmho/cm2) | Soil Fertility P (ppm) | Soil Fertility K (ppm) | Soil Fertility Lime * | CEC** (meq/100g) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0-24 | Sandy Clay Loam | 8.0 | 0.6 | 2.3 | 372 | ++ | 13.3 |
| 2 | 24-33 | Sandy Loam | 8.3 | 0.6 | 1.0 | 280 | ++ | 8.3 |
| 3 | 33-38 | Sandy Clay Loam | 8.2 | 0.6 | 2.4 | 340 | ++ | 10.0 |
| 4 | 38-46 | Sandy Loam | 8.4 | 0.5 | 1.0 | 152 | ++ | 6.6 |
| 5 | 46-64 | Loam | 8.2 | 0.6 | 2.5 | 293 | ++ | 22.8 |
| 6 | 64-90 | Loam | 8.2 | 0.4 | 2.5 | 196 | ++ | 18.5 |
| 7 | 90-102 | Sandy Loam | 8.0 | 2.0 | 1.2 | 38 | ++ | 8.2 |
| 8 | 102-152 | Sandy Clay Loam | 8.0 | 3.2 | 3.2 | 65 | ++ | 10.8 |

| Horizon | Ammonium Acetate Extractable Ions (meq./100g) Na | K | Ca | Mg | Saturation Percentage | Water Soluble Ions (meq./100g) Na | K | Ca | Mg | meq/L in Sat. Ext. Chloride | Bicarbonate | SAR*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.33 | 0.89 | 37.8 | 2.6 | 36.3 | 0.02 | 0.09 | 0.1 | 0.03 | 0.3 | <0.5 | 0.08 |
| 2 | 0.44 | 0.64 | 36.9 | 2.1 | 27 | 0.02 | 0.07 | <0.1 | 0.02 | 0.2 | 3.9 | --- |
| 3 | 0.44 | 0.89 | 38.6 | 3.6 | 42.6 | 0.06 | 0.09 | 0.1 | 0.05 | 0.2 | 4.3 | 0.22 |
| 4 | 0.33 | 0.38 | 28.9 | 2.1 | 25.7 | 0.03 | 0.04 | <0.1 | 0.03 | 0.2 | 3.6 | --- |
| 5 | 0.44 | 0.7 | 44.7 | 5.1 | 48.7 | 0.07 | 0.04 | 0.1 | 0.07 | <0.1 | 5 | 0.24 |
| 6 | 0.44 | 0.51 | 41.1 | 4.4 | 48.8 | 0.05 | 0.04 | 0.1 | 0.06 | <0.1 | 3.4 | 0.18 |
| 7 | 1.42 | 0.19 | 34.2 | 3.1 | 28.8 | 0.09 | 0.01 | 0.3 | 0.19 | 5.3 | 2.6 | 0.18 |
| 8 | 0.54 | 0.19 | 37.3 | 4.9 | 39.1 | 0.21 | 0.02 | 0.6 | 0.48 | 11.7 | 2.5 | 0.29 |

* Lime is indicated relative. Here, ++ means lime is high.
** CEC = Cation Exchange Capacity
*** SAR = Sodium Adsorption Ration

PacifiCorp
Trail Mountain Mine

**Table 2-5**

**TABLE 8-3**
**GRASSLAND-SHRUB TEXTURAL ANALYSIS**

| | Horizons | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Thickness (cm) | 24 | 9 | 5 | 8 | 18 |
| Color | Reddish-brown | Yellowish-gray | Gray | Yellowish-gray | Gray |
| Structure | None | Gravelly | Caked Hard-pan | Clay | Clay |

**Weight Percents of Bulk Soil**

| | | | | | |
|---|---|---|---|---|---|
| % Rock > 2mm* | 28.50% | 46.40% | 49.70% | 40.30% | 66.30% |
| % Soil < 2mm | 71.50% | 53.60% | 50.30% | 59.70% | 33.40% |

**Weight Percents of Soil Fractions < 2mm**

"Old Method" (2nd Hydrometer Reading at 1 Hour)

| | | | | | |
|---|---|---|---|---|---|
| % Sand | 40.20% | 17.00% | 10.80% | 12.00% | 14.20% |
| % Silt | 35.20% | 47.20% | 46.00% | 50.00% | 52.00% |
| % Clay | 24.60% | 25.80% | 43.20% | 38.00% | 33.80% |
| Texture Class | Loam | Silty Clay Loam | Silty Clay | Silty Clay Loam | Silty Clay Loam |

"New Method" (2nd Hydrometer Reading at 2 Hours)

| | | | | | |
|---|---|---|---|---|---|
| % Sand | 40.20% | 17.00% | 10.80% | 12.00% | 14.20% |
| % Silt | 38.80% | 61.40% | 51.80% | 57.60% | 56.80% |
| % Clay | 21.00% | 21.60% | 37.40% | 30.40% | 29.00% |
| Texture Class | Loam | Silty Loam | Silty Clay Loam | Silty Clay Loam | Silty Clay Loam |

* Tyler Screen, #10 mesh = 1.981 mm openings

**Table 2-6**

**TABLE 8-4**
**SOIL CHEMISTRY: GRASSLAND SHRUB REFERENCE AREA**

| Horizon | Depth (cm) | Soil Texture Class | Acidity (pH) | Salinity (mmho/cm2) | Soil Fertility P (ppm) | Soil Fertility K (ppm) | Soil Fertility Lime * | CEC** (meq/100g) |
|---|---|---|---|---|---|---|---|---|
| 1 | 0-13 | Loam | 8.2 | 0.4 | 0.9 | 95 | ++ | 9.0 |
| 2 | 13-28 | Silty Clay Loam | 8.3 | 0.4 | 0.9 | 63 | ++ | 8.2 |
| 3 | 28-33 | Silty Clay | 8.5 | 0.3 | 0.6 | 80 | ++ | 7.6 |
| 4 | 33-39 | Silty Clay Loam | 8.7 | 0.3 | 0.4 | 53 | ++ | 4.5 |
| 5 | 39-50 | Silty Clay Loam | 8.7 | 0.4 | 0.6 | 75 | ++ | 6.3 |

| Horizon | Ammonium Acetate Extractable Ions (meq./100g) Na | K | Ca | Mg | Saturation Percentage | Water Soluble Ions (meq./100g) Na | K | Ca | Mg | meq/L in Sat. Ext. Chloride | Bicarbonate | SAR*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.33 | 0.26 | 36.6 | 2.3 | 32.4 | 0.02 | 0.01 | 0.1 | 0.03 | 0.3 | 3.2 | 0.08 |
| 2 | 0.44 | 0.32 | 34.7 | 3.6 | 38.6 | 0.02 | 0.01 | 0.1 | 0.06 | <0.1 | 3.5 | 0.07 |
| 3 | 0.33 | 0.26 | 36.1 | 5.7 | 42.7 | 0.03 | 0.01 | <0.1 | 0.07 | 0.2 | 2.5 | --- |
| 4 | 0.33 | 0.19 | 36.7 | 4.9 | 48 | 0.02 | 0.01 | <0.1 | 0.07 | <0.1 | 2.5 | --- |
| 5 | 0.33 | 0.26 | 37 | 6.4 | 49.4 | 0.03 | 0.01 | <0.1 | 0.1 | 0.6 | 2.9 | --- |

* Lime is indicated relative. Here, ++ means lime is high.
** CEC = Cation Exchange Capacity
*** SAR = Sodium Adsorption Ration

# APPENDIX 2-1

# COTTONWOOD COAL LEASE

# ENVIRONMENTAL IMPACT STATEMENT (EIS)

The permittee does not have access to a final version of the Cottonwood Coal Lease Tract UTU-68012, Environmental Impact Statement (EIS).

This appendix contains excerpts from the information we have. We do not have copies of the associated technical reports. Our research did not produce a copy of the EIS or the associated technical reports. As a cooperating agency the Division may have a copy of the EIS with associated reports.

The notice in the Federal Register on Thursday, February 19, 1998 for the third-party Environmental Impact Statement is also in the appendix. The information was compiled by David Evans and Associates, Inc acting as the third-party for the USDA Forest Service.

When the Cottonwood Lease was acquired by the permittee it was smaller than the original UTU-68012 Tract (federal) and becomes Lease ML51191 OBA (SITLA). Therefore, several of the concerns covered in the original Tract EIS do not apply to the reduced Lease ML51191 OBA, such as the concerns about the Joes Valley dam and reservoir, etc.

Due to the age of the EIS a percentage of the information has been updated, therefore the information is presented as historic information and as reference material.

including objectives, proposed activities, benefits to U.S. agricultural exports, target country/countries for proposed activities, projected starting date for project, and funding amount requested; summary and detailed description of proposed project; statement of problem (specific trade constraint) to be addressed through the proposed project; benefits to U.S. agricultural exports; agricultural trade data for target country/countries, including existing percentage of U.S. export market share; information on whether similar activities are or have previously been funded in target country/countries (e.g., under MAP and/or FMD programs); a clearly stated explanation as to why participating organization(s) are unlikely to carry out activities without Federal financial assistance; time line(s) for project implementation; detailed project budget, including other sources of funding for the project and contributions from participating organizations (additional requirements are contained in the Program Guidelines); Federal tax ID number of the responsible organization. Qualifications of applicant(s) should be included, as an attachment.

Signed at Washington, D.C., on February 11, 1998.

**Lon Hatamiya,**

*Administrator, Foreign Agricultural Service.*

[FR Doc. 98-4169 Filed 2-18-98; 8:45 am]

**BILLING CODE 3410-10-M**

## DEPARTMENT OF AGRICULTURE

### Forest Service

### Cottonwood Coal Lease Tract, UTU-68012; Manti-La Sal National Forest, Emery County, Utah

**ACTION:** Notice of intent to prepare a third-party Environmental Impact Statement.

**SUMMARY:** The Forest Service and Bureau of Land Management will direct preparation of a Third-Party Environmental Impact Statement (EIS) to document the analysis and disclose the environmental and human effects of proposed actions to offer the Cottonwood Coal Lease Tract for competitive bidding in accordance with 43 CFR part 3425. As the surface management agency, the Forest Service will be the lead agency for preparation of the EIS and the Bureau of Land Management will be a joint lead agency. The Office of Surface Mining and Bureau of Reclamation will also participate as cooperating agencies.

The coal lease tract, as delineated by the Tract Delineation Team, encompasses 9,243.87 acres of Federal coal lands on the Manti-La Sal National Forest as follows:

T. 17 S., R. 6 E., SLM,
Section 2, SW4;
Section 3, lots 1-12, SE4;
Section 4, lots 1-2, S2NE4, SE4;
Section 9, E2, E2W2;
Section 10, lots 1-8, E2;
Section 11, All;
Section 12, W2W2;
Section 13, W2W2;
Section 14, lots 1-4, E2, NW4;
Section 15, lots 1-12, NE4;
Section 16, NE4NW4;
Section 20, E2E2;
Section 21, All;
Section 22, All;
Section 23; lots 1-12, NE4;
Section 24, W2W2;
Section 25, N2NW4;
Section 26, N2NE4, W2SW4NE4, NW4, N2SW4, W2NW4SE4;
Section 27, N2, N2S2;
Section 28, All;
Section 29, E2;
Section 32, E2;
Section 33; All.

(Additions and/or deletions to the delineated tract may be considered as alternatives to the proposed action, to be developed and analyzed based on issues and management needs.)

PacifiCorp applied to the Bureau of Land Management for the lease to obtain additional coal reserves to increase the production life of their Cottonwood/Wilberg/Trail Mountain mine complex. The tract lies west and north of the boundary of the existing approved permit area for the Trail Mountain Mine. If PacifiCorp obtains the tract, it would be mined by longwall and room-and-pillar methods through underground workings in the existing permit area. Existing portal facilities in Cottonwood/Wilberg/Trail Mountain mine comples would be used. If another company obtains the tract, it is most likely that new portal facilities would be required in Cottonwood Canyon, north of the existing Trail Mountain Mine facility. The underground mining methods and layout would be similar. The EIS would consider the effects of both scenarios, the No Action Alternative, and other alternatives to be developed after completion of project scoping.

**AGENCY DECISIONS:** In accordance with the Coal Leasing Amendments Act of 1975, which amended the Mineral Leasing Act of 1920, the Forest Supervisor, Manti-La Sal National forest, must decide whether or not to consent to leasing by the Bureau of Land Management and identify special coal lease stipulations needed to protect non-mineral resources.

In accordance with the Mineral Leasing Act of 1920, as amended, the Utah State Director of the Bureau of Land Management must decide whether or not to offer the tract for competitive leasing and under what terms, conditions, and stipulations.

**DATES:** Written comments concerning the scope of the analysis described in this notice should be received on or before March 23, 1998.

**ADDRESSES:** Send written comments to Manti-La Sal National Forest, 599 West Price River Drive, Price, Utah 84501.

**FOR FURTHER INFORMATION CONTACT:** Questions concerning the proposed action and EIS should be addressed to Dale Harber or Aaron Howe, Manti-La Sal National Forest, phone (435) 637-2817.

**SUPPLEMENTARY INFORMATION:** This EIS will tier to the Final EIS and Record of Decision for the Manti-La Sal National Forest Land and Resource Management Plan (Forest Plan). The Manti-La Sal Forest Plan provides the overall guidance (Goals, Objectives, Standards, and Management Area Direction) to achieve the Desired Future Condition for the area being analyzed, and contains specific management area prescriptions for the entire Forest. The proposed lease tract is available for further consideration for coal leasing. The Forest Service and Bureau of Land Management have determined that data are available to meet the Data Adequacy Standards for Federal Coal Leasing, Uinta-Southwestern Utah Coal Region.

Issues and alternatives to be evaluated in the analysis will be determined through public scoping. The major issues are expected to include the socioeconomic benefits of mining; the potential impacts of underground mining and mining-induced subsidence to surface and ground water, vegetation, wildlife, cultural/paleontological resources, range improvements, and other land uses; the potential for impacts on the Joes Valley Dam; and the potential impacts of any new surface facilities to the Forest and human environments.

The Forest Service is seeking information and comments from Federal, State, and local agencies as well as individuals and organizations who may be interested in, or affected by, the proposed action. The Forest Service invites written comments and suggestions on the issues related to the proposal and the area being analyzed. Information received will be used in preparation of the Draft EIS and Final

EIS. For most effective use, comments would be submitted to the Forest Service within 30 days from the date of publication of this notice in the **Federal Register**. Preparation of the EIS will include the following steps:

1. Define the purpose of and need for action.
2. Identify potential issues.
3. Eliminate issues of minor importance or those that have been covered by previous and relevant environmental analysis.
4. Select issues to be analyzed in depth.
5. Identify reasonable alternatives to the proposed action.
6. Describe the affected environment.
7. Identify the potential environmental effects of the alternatives.

Steps 2, 3, and 4 will be completed through the scoping process.

Step 5 will consider a range of alternatives developed from the key issues and management needs. At a minimum, the "No Action" and "Propose Action" Alternatives will be analyzed. Other alternatives could involve modified tract boundaries (additions and/or reductions) and different sets of special lease stipulations for the protection of non-mineral resources. Alternatives may also be developed to include analysis of mining in the existing adjacent lease area and a potential modification of adjacent existing leases to add up to 160 acres/lease to prevent bypassing minable reserves.

Step 6 will describe the physical attributes of the area to be affected by this proposal, with special attention to the environmental factors that could be adversely affected.

Step 7 will analyze the environmental effects of each alternative. This analysis will be consistent with management direction outlined in the Forest plan. The direct, indirect, and cumulative effects of each alternative will be analyzed and documented. In addition, the site specific mitigation measures for each alternative will be identified and the effectiveness of these mitigation measures will be disclosed.

Agency representatives and other interested people are invited to visit with Forest Service officials at any time during the EIS process. Two specific time periods are identified for the receipt of formal comments on the analysis. The two comment periods are, (1) during the scoping process, the next 30 days following publication of this Notice in the **Federal Register**, and (2) during the formal review period of the Draft EIS.

The Draft EIS is estimated to be filed with the Environmental Protection Agency (EPA) and available for public review in September, 1998. At this time the EPA will publish an availability notice of the Draft EIS in the **Federal Register**.

The comment period on the Draft EIS will be 45 days from the date the Environmental Protection Agency's notice of availability appears in the **Federal Register**. It is very important that those interested in this proposed action participate at that time. To be the most helpful, comments on the Draft EIS should be as specific as possible and may address the adequacy of the statement or the merits of the alternatives discussed (See The Council on Environmental Quality Regulations for implementing the procedural provisions of the National Environmental Policy Act at 40 CFR 1503.3).

In addition, Federal court decisions have established that reviewers of draft environmental impact statements must structure their participation in the environmental review of the proposal so that it is meaningful and alerts an agency to the reviewers' position and contentions. *Vermont Yankee Nuclear Power Corp.* v. *NRDC, 435 U.S. 519, 553 (1978).* Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the final environmental impact statement. *City of Angoon* v. *Hodel, (9th Circuit, 1986)* and *Wisconsin Heritages, Inc.* v. *Harris, 490 F. Supp. 1334, 1338 (E.D. Wis. 1980).* The reason for this is to ensure that substantive comments and objections are made available to the Forest Service at a time when it can meaningfully consider them and respond to them in the final document.

To assist the Forest Service in identifying and considering issues and concerns related to the proposed action, comments on the Draft EIS should be as specific as possible. Referring to specific pages or chapters of the Draft EIS is most helpful. Comments may also address the adequacy of the Draft EIS or the merits of the alternatives formulated and discussed in the statement. (Reviewers may wish to refer to the Council on Environmental Quality Regulations for implementing the procedural provisions of the National Environmental Policy Act, 40 CFR 1503.3, in addressing these points.)

The final EIS is expected to be released in December, 1998.

The Forest Supervisor for the Manti-La Sal National Forest and Utah State Director of the Bureau of Land Management, who are the responsible officials for the EIS, will then make their respective decisions regarding this proposal, after considering the comments, responses, and environmental consequences discussed in the Final Environmental Impact Statement, and applicable laws, regulations, and policies. The rationale for the respective agency decisions will be documented in the Record(s) of Decisions.

Dated: February 11, 1998.

**Janette S. Kaiser,**

*Forest Supervisor, Manti-La Sal National Forest.*

[FR Doc. 98-4168 Filed 2-18-98; 8:45 am]

BILLING CODE 3410-11-M

## DEPARTMENT OF AGRICULTURE

### Rural Business—Cooperative Service

### Notice of Request for Extension of a Currently Approved Information Collection

**AGENCY:** Rural Business—Cooperative Service, USDA.

**ACTION:** Proposed collection; comments request.

**SUMMARY:** In accordance with the Paperwork Reduction Act of 1995, this notice announces the intention of the Rural Business-Cooperative Service (RBS) to request an extension for a currently approved information collection in support of the Cooperative Development Division (CDD), Cooperative Development Program.

**DATES:** Comments on this notice must be received by April 20, 1998 to be assured of consideration.

**FOR FURTHER INFORMATION CONTACT:** John Wells, Director, Cooperative Development Division, Rural Business-Cooperative Service, USDA, STOP 3254, 1400 Independence Avenue, SW., Washington, DC 20250-3254, Telephone: (202) 720-3350.

**SUPPLEMENTARY INFORMATION:**

*Title:* Cooperative Services Questionnaire:

New Cooperative Volume and Structure, Producer Survey for New Cooperative Activity.

*OMB Number:* 0570-0008.

*Expiration Date of Approval:* May 31, 1998.

*Type of Request:* Extension of a currently approved information collection.

*Abstract:* The Rural Business-Cooperative Service (RBS) Cooperative Services Programs conducts feasibility studies to assist in the development of new cooperatives. The Cooperative Development Division (CDD) specializes

# 1.0 COTTONWOOD COAL LEASE TRACT UTU-68012 APPLICATION BY PACIFICORP (ENERGY WEST MINING COMPANY)

## 1.1 INTRODUCTION

PacifiCorp (Energy West Mining Company) submitted a coal lease application for the Cottonwood Lease Tract to the Bureau of land Management. The tract boundaries were delineated by the Interagency Tract Delineation Team. The tract is located to the west and north of Energy West's approved permit area for their Trail Mountain Mine (Figure 1.1-1).

The Manti-La Sal National Forest (Forest Service) and Bureau of Land Management (BLM), Utah State Office, are jointly responsible for conducting an environmental analysis. The Office of Surface Mining (OSM) and Bureau of Reclamation (BOR) will participate as cooperating agencies. The responsible officials of the Forest Service and the BLM have decided to prepare an Environmental Impact Statement (EIS), upon which to base the respective agency leasing decisions.

## 1.2 EXISTING MINES AND RELATIONSHIP TO LEASING PROPOSAL

An explanation of the names of existing mines is provided to avoid confusion with the proposed action.

The Cottonwood and Wilberg are separate mines in the Hiawatha coal seam, which use the same Cottonwood surface facilities (including portal) (Figure 1.2-1). The Trail Mountain Mine also uses the Cottonwood/Wilberg surface facilities (accessed by conveyor belt through Cottonwood Mine). The Cottonwood Lease Tract is the proposed area for additional coal leasing and would become part of the Trail Mountain Mine if PacifiCorp (Energy West) were to obtain the lease. Coal produced from the Cottonwood Lease Tract would be transported along the same path, via conveyor belt, as is currently being used at the Trail Mountain Mine.

The Deer Creek Mine is in the Blind Canyon seam, above the Hiawatha seam. The Deer Creek Mine has its own surface facilities (including portal). Cottonwood, Wilberg, and Deer Creek Mines are all on East Mountain, while the proposed Cottonwood Lease Tract is primarily on Trail Mountain (a portion of the northeast corner, east of Cottonwood Canyon, is on East Mountain).

The coal is hauled by truck from the Cottonwood/Wilberg Tipple to the Cottonwood Preparation Facility, located near the Hunter Power Plant (Figure 1.2-1).

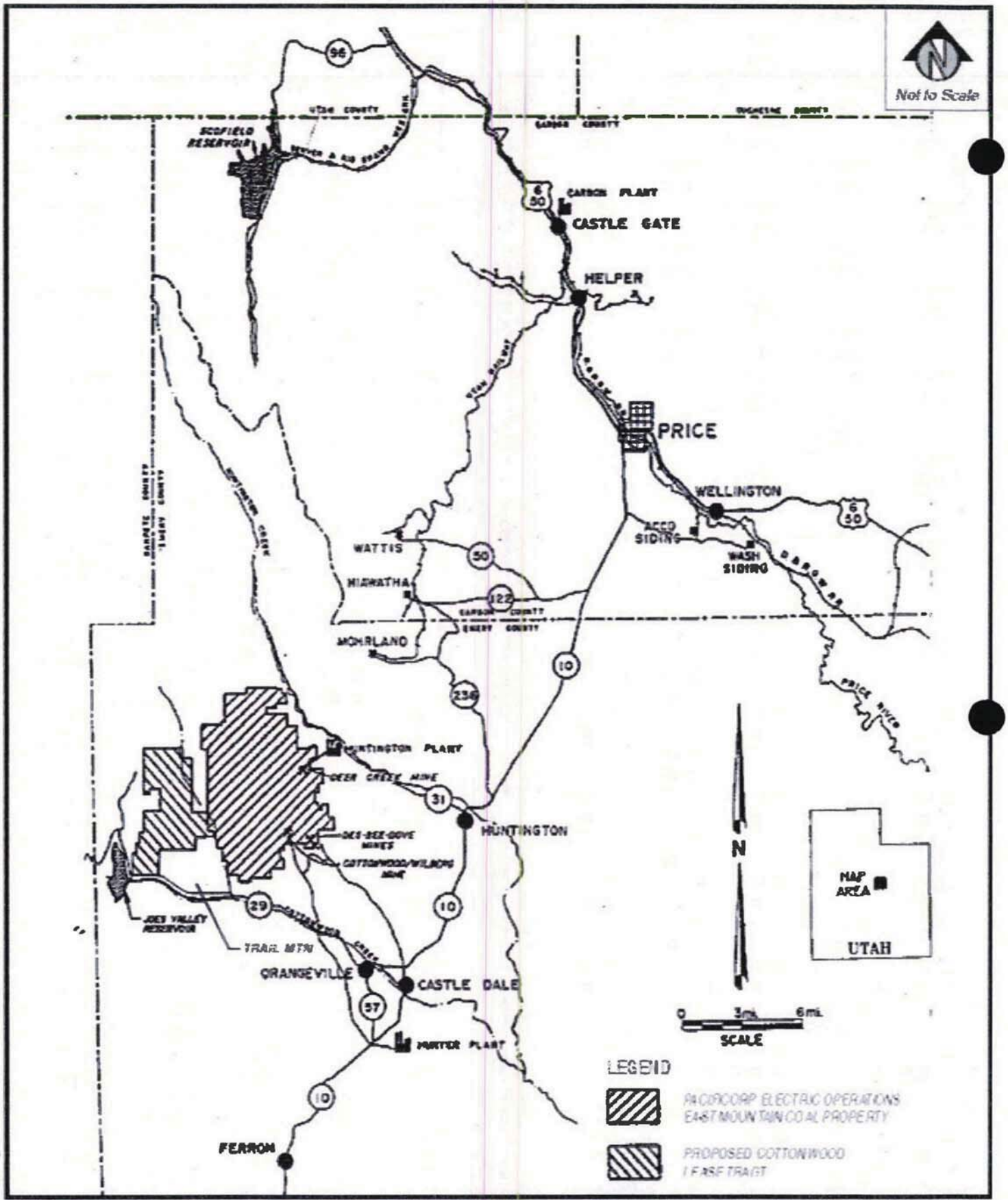
## 1.3 PURPOSE AND NEED AND DESCRIPTION OF THE PROPOSED ACTION

The Forest Service and BLM propose to offer the Cottonwood Coal Lease Tract for competitive leasing based on Energy West's application for lease as modified by the Interagency Tract Delineation Team. The Cottonwood Tract is the last available coal reserve that can be accessed and mined by the Trail Mountain Mine. Successful acquisition of the subject lease tract by Energy West will extend the life of the Trail Mountain Mine which would otherwise be mined out at the end of the year 2001. The Trail Mountain Mine is an underground coal mine as would be the Cottonwood Tract.

The Cottonwood Tract lies on Trail Mountain in the Wasatch Plateau and within the Wasatch Plateau Known Recoverable Coal Resource Area. It lies directly to the west and north of the permit area for Energy West's Trail Mountain underground coal mine. The lease tract consists of 9,243.87 acres and is located approximately 10 miles northwest of Orangeville, Emery County, Utah. The surface of the area is administered by the Forest Service and the mineral estate is administered by the BLM.

The Cottonwood Lease Tract is adjacent to the currently operating Trail Mountain Coal Mine. This tract is proposed as an extension of the Trail Mountain Mine. Therefore, the additional surface disturbance associated with the Cottonwood Lease Tract would be minimal.

Figure 1.1-1: Vicinity Map




**SOURCE**
*Energy West Mining Company, 1998*

## Cottonwood Lease Tract EIS
## Vicinity Map

| | | |
|---|---|---|
| EWMC0001 | DAVID EVANS AND ASSOCIATES, INC. | FIG. 1.1-1 |
| May 1999 | | Sheet 1 of 1 |

Hal Draftingdb 1 ave/EWMC0001-Fig 1.1-1.dgn

## 3.1 GEOLOGY

### 3.1.1 Executive Summary

The geologic setting ultimately determines the potential for successful mining using today's state-of-the-art mining technologies. Prior mining within the adjacent Trail Mountain Mine indicates that longwall mining across the proposed Cottonwood Lease Tract is likely possible, despite the presence of problematic structural features, including faults, grabens, rock spars, igneous dikes and sills, sandstone channels, etc. Portions of the Hiawatha Seam may be problematic to mine, and other areas may have to be abandoned or avoided due to ground instabilities and potential water inundation issues. Experience at the neighboring East Mountain operations suggest that fault and graben features may present the greatest challenges to mining for the Cottonwood Lease Tract, with the Roan's Canyon, Mill Fork, and Joes Valley Fault and associated graben features the most noteworthy areas of concern.

**Environmental Consequences.** Aside from structural features, the Castlegate Sandstone formation appears to be the most sensitive of the units overlying the Hiawatha Seam in terms of contribution to potential damage of surface resources. This unit is largely responsible for the majority of large seismic events occurring in the central Utah coalfields (attributable to poor, untimely caving), and forms the primary escarpment along the lease tract outcrop. Escarpment failures due to full-extraction undermining have raised concerns regarding hazards to the public, loss of wildlife habitats, damage to sensitive flora species, and damage to the architecture of the escarpments (alcoves, arches, bridges, towers, pinnacles, etc.). Overlying formations may actually contribute to improved hydrologic conditions following full subsidence, particularly the North Horn Formation which is comprised of a high percentage of swelling bentonite clay—which quickly seals water pathways resulting from tension cracking associated with mining-induced subsidence.

**Areas of Controversy and Issues to be Resolved.** The geologic setting greatly affects both mining-induced subsidence and seismicity, primarily contributing to potentially large seismic events and delayed subsidence. The strong sandstone units overlying the seam (namely the Castlegate Sandstone, upper Blackhawk Formation, and Price River Formation sandstones) inhibit timely caving and full-subsidence, resulting in high stress concentrations about the periphery of large mined out panel regions within the seam. Sudden failure of the coal seam and caving of the immediately surrounding strata can result in sizable energy releases within the mine—creating a major safety hazard for underground workers. Untimely and discontinuous subsidence resulting from nonuniform failure of the overburden strata creates unpredictable surface subsidence profiles as a function of mining progress and future planning. On-going efforts to provide more detailed information regarding the geologic setting will greatly improve the predictability of seismic events and planned subsidence as mining proceeds across the Cottonwood Lease Tract.

### 3.1.2 Introduction

The Cottonwood Lease Tract is located beneath Trail Mountain near the center of the Wasatch Plateau, largely bounded by Cottonwood Canyon, Straight Canyon, and the Joes Valley Fault. Proposed mining would extract the Hiawatha Seam, the basal coal seam within the Blackhawk Formation and the primary mineable coal formation in the plateau. Overlying seams are not of sufficient thickness or quality to be mined, so single seam mining would only be practiced across the entire lease area. The primary structures affecting future mining on the property include faults (Roan's Canyon, Mill Fork, and potential sympathetic structures along the Joes Valley Fault), grabens (down-dropped blocks between faults), rock spars, igneous dikes and sills, and seam-scouring sand channels. The Castlegate Sandstone represents one of the major depositional formations potentially affecting mining, forming the primary escarpment around the periphery of the property. The Flat Canyon anticline to the north and Straight Canyon syncline to the south are the primary features controlling seam grades and elevations across the property.

Geologic information relative to the regional and local mining setting was acquired from **(1)** on-site observations during a recent site visit and underground tour of the current Trail Mountain operation, **(2)** discussions with mine geologists during this site visit concerning the structural and depositional environment encountered at Trail Mountain and the neighboring operations at East Mountain, **(3)** drill hole logs for the proposed lease tract provided by Energy West Mining Company, and **(4)** various documents describing the depositional and tectonic environment of the area—including the detailed work of Doelling (1972), and others. Limited geophysical measurements have also been conducted over portions of the property to ascertain the existence of fault and graben structures; however, the work has not yet been completed, and does not fully characterize the entire property. Site characterization is understood to be an on-going process for any new mining operation; however, the proposed Cottonwood lease benefits considerably from the information gained during mining within the adjacent and existing Trail Mountain operation, as well as the neighboring Deer Creek, Cottonwood, Wilberg, and Des-Bee-Dove operations at East Mountain.

### 3.1.3 Affected Environment

#### *General Mine Setting*

The Cottonwood and Trail Mountain Lease Tracts are located near the center of the Wasatch Plateau coalfield, 3 miles from the mouth of Cottonwood Canyon, and 11 miles west of Orangeville. The coalfield is oriented nearly north-south, and is bounded to the east by an erosional escarpment; the western boundary roughly parallels the drainage divide of the Wasatch Plateau. The plateau has a vertical relief of up to 2,500 feet, rising from Castle Valley below. In the vicinity of Trail Mountain the terrain can be characterized by narrow, flat-topped mesas surrounded by heavily-vegetated slopes which extend to precipitous cliffs leading to the valley and canyons below.

The Wasatch Plateau coalfield was formed along the western shoreline of the Cretaceous Interior Seaway. Sediments deposited in the sea and coastal areas were derived mainly from western Utah. The Cretaceous Interior Seaway level oscillated due to tectonic events, forming marine and non-marine sequences characteristic of fluvial, wave-dominated delta, and strand-plain deposits. Formations exposed in the Trail Mountain region range from Upper Cretaceous to Tertiary. Older Cretaceous formations, including members of the Mancos Shale, are exposed in Castle Valley and extend to the escarpment at the eastern edge of the plateau. The steeper sections of the escarpment belong to the Mesaverde Group formations, and the uppermost units on the plateau are the latest Cretaceous and early Tertiary rocks (Doelling, 1972).

Formations in the Trail Mountain area, in ascending order, are the Masuk Shale member of the Mancos Shale, Starpoint Sandstone, Blackhawk, Castlegate Sandstone, Upper Price River, North Horn, and Flagstaff Limestone. They may individually be described as follows (Doelling, 1972; EWMC, 1997; Stokes, 1988):

- The **Masuk Shale** is a massive, dry shale member, approaching 1,300 feet in thickness, which immediately underlies the Starpoint Sandstone. This unit is quite soft, yet contains

significant thin sandstone units near the top of the formation.

- The **Starpoint Sandstone** is comprised of three main units; the basal Panther Sandstone (~100 feet thick), the Storrs Sandstone (~50 feet thick), and the upper Spring Canyon Sandstone (~100 feet thick). Locally the Starpoint Sandstone exhibits aquifer characteristics; however, this unit is generally considered a poor aquifer due to low permeability and limited recharge. These sandstone units are prominent cliff-forming members in the region, and are clearly discernible along the eastern escarpment of the plateau.
- The **Blackhawk Formation** is the main coal-bearing unit in the region, and ranges from 625 to 800 feet thick in the Trail Mountain Area. This formation consists of alternating sandstones, siltstones, shales, and coal seams deposited in a deltaic environment. Sandstones are generally fluvial in origin, and although these units typically reside in the upper portions of the formation, channeling at seam level may be present immediate to the Hiawatha Seam. Numerous thick shale units exist within the Blackhawk, providing significant barriers to the vertical movement of water. The ratio of sandstones to shales varies across the plateau; however, in the vicinity of Trail Mountain slightly larger portions of shale units are present (on the average). The mineable coal units are all located within the lower 150 feet of the formation. The Hiawatha Seam (to be solely mined across the Cottonwood Lease Tract) lies immediately above the Starpoint Sandstone, though in some places 1 to 15 feet of intervening shale may be present. The seam is of variable, yet mineable thickness, and is overlain by 1 to 5 feet of alternating mudstones, coal rider seams, and thin sandstones, which is overlain by a thick fluvial sandstone forming a good support horizon.
- The **Castlegate Sandstone** ranges in thickness from 170 to 350 feet across the Trail Mountain property, and lies directly above the Blackhawk Formation. This formation is the predominant cliff-forming member in the Wasatch Plateau, providing the massive escarpments above Cottonwood Canyon and Straight Canyon. The member is not always continuous in nature, and is often broken by thin shale members.
- The **Upper Price River Formation**, overlying the Castlegate Sandstone, is approximately 350 feet thick in the mine area and forms the step-like slopes above the Castlegate escarpment. Although some mudstones are present, weak, friable, poorly-sorted sandstones predominate the formation. This unit is generally devoid of water due to a lack of adequate recharge.
- Overlying the Price River Formation is the **North Horn Formation**; ranging in thickness over the Cottonwood Lease Tract from 750 to 800 feet. This formation has been described as containing a highly varied assemblage of rock types, ranging from numerous shales to thin sandstones to fresh water limestone beds. Lenticular sandstones exist in the upper and lower portions of the formation, and provide for isolated springs where they intersect the surface. The lower two-thirds of the formation consists of highly bentonitic mudstone, which is impermeable, swelling on contact with migrating water.
- The **Flagstaff Limestone** forms the uppermost peaks and caps on the Wasatch Plateau, and provides for the ridgeline immediately above the central portion of the Cottonwood Lease Tract. This unit consists of thin-bedded lacustrine limestone with some thin beds of gray shale and white volcanic ash. This formation displays a strong joint pattern which permits good groundwater movement both vertically and horizontally through the formation.

Strata in the northern portion of Trail Mountain are gently up-folded into the Flat Canyon anticline, with strata in the southern area gently dipping into the Straight Canyon Syncline. Both structures have a northeasterly bearing and plunge gently to the southwest. Strata across the Trail Mountain property dip from 2° to 3°, rarely exceeding 5° (EWMC, 1997).

Overburden within the proposed lease area ranges from approximately 750 feet, to in excess of 2,500 feet. The overburden is greatest within the central portion of the tract where the plateau is capped by the Flagstaff Limestone. Areas of the property under cover depths in excess of 1,500 feet,

particularly where the Castlegate sandstone thickens to over 300 feet, are especially susceptible to larger mining-induced seismicity events (3.0ΩM$_L$Ω4.0: see Appendix 3.2-A on seismicity).

Rock spars (small veins), or clastic dikes and sills, ranging from several inches to several feet in thickness have been encountered in the vicinity of the existing Trail Mountain Mine (EWMC, 1997). These features have been injected or intruded within the seam, generally from the floor, and present adverse mining conditions and/or coal quality issues. Individual spars can be traced for hundreds of feet through the present mine workings, and typically occur in "swarms" with northeasterly bearings. The material comprising the spars is a light gray crystalline dolomite with minor amounts of quartz sand. This material is dense, hard, abrasive, and extremely tough making cutting even thin spars very difficult to impossible. Development mining has been slowed and/or stopped in many areas where spars have been encountered in recent mining within the Cottonwood and Trail Mountain Mines. At least one significant igneous dike (identified to run along the surface for approximately 500 feet) has also been located in the vicinity of the proposed lease tract. As with clastic dikes and sills, igneous dike material is extremely hard and nearly impossible to mine even thin intrusions.

### *Faulting*

Faulting in the Wasatch Plateau region is largely the result of the Sevier Orogenic Belt uplift to the west coupled with periods of subsidence within the Cretaceous Interior Seaway to the east (Stokes, 1988). The intervening region of high depositional activity was subject to a predominant east-west compressional tectonic stress regime which, following deposition of the North Horn Formation, was sufficient to create numerous northwest-southeast and northeast-southwest strike-slip faults (Doelling, 1972; EWMC, 1997). The Mill Fork and Roan's Canyon Faults are excellent examples of such features. Following the deposition of the Flagstaff Limestone, normal gravity displacement began to occur along these faults.

Sometime during the deposition of the Flagstaff Limestone, the east-west compression relaxed and was replaced with an extensional, or tensional, stress regime. This change in stress environment resulted in the development of numerous north-south trending fault grabens, including the major trends of the North Gordon, Pleasant Valley, Joes Valley, and Musina Fault Zones. Numerous sympathetic features also exist in conjunction with these major fault and graben trends, though most displacement decreases significantly toward the southern reaches of the system. (For example, where the Pleasant Valley Fault has nearly 1,500 feet of vertical displacement evident in the Scofield area to the north, total displacement dropped to less than a foot within the Wilberg Mine under East Mountain to the east of the current proposed lease tract).

The most substantial fault system potentially affecting the Cottonwood lease is the Joes Valley Fault Graben, bounded by the Joes Valley Fault on the east (western flank of the proposed lease tract). This feature lies approximately 1,000 feet to the west of the western boundary of the proposed lease tract, and exhibits nearly 2,300 vertical feet of displacement. It is apparent that the extensional stress regime responsible for the major graben formations within the region was also responsible for the formation of the Roan's Canyon and Mill Fork grabens. The Roan's Canyon fault graben has a maximum vertical displacement of approximately 160 feet where it was crossed in the Deer Creek Mine to the northeast; however, measurements across the Cottonwood Lease Tract indicate that it has lost all vertical displacement in this area. The Mill Fork Fault graben also shows similar trends of diminishing vertical displacement toward the southwest. Both fault systems exist within the proposed lease tract, however, their impact on mining, from a structural stability perspective, is considered minor. Sympathetic faulting associated with the Joes Valley Fault has also been mapped within the Mill Fork Tract at the Genwal Resources, Inc., Crandall Canyon Mine, north of the proposed Cottonwood Lease Tract (USDA, 1997). It is possible that such features may be present along the western boundary of the Cottonwood Tract.

Both the Roan's Canyon and Mill Fork Fault systems are very important hydrologically, with numerous springs present along their traces both on East Mountain and within the proposed lease tract (EWMC, 1997). All major springs within the Cottonwood Lease Tract area are closely related to these faults, and exhibit surface hydrologic conditions similar to those found on East Mountain.

University of Utah, Salt Lake City, UT, Monograph Series No.3, 1972, pp.59-131.

PacifiCorp/Energy West Mining Company, 1997. Cottonwood Canyon Tract Lease-By-Application No.8—Data Adequacy: Geologic Section. Prepared by Energy West Mining Company, Huntington, UT, 12 pp.

Stokes, W.L., 1988. Geology of Utah. Utah Museum of Natural History, University of Utah, and Utah Geological and Mineral Survey, Department of Natural Resources, Salt Lake City, UT, 280 pp.

USDA, Forest Service, Region 4, 1997. Mill Fork Federal Coal Lease Tract UTU-71307 Environmental Assessment Lease-By-Application No.11. Available USDA, Forest Service, Region 4—Manti-La Sal National Forest Office, 599 W. Price River Dr., Price, UT, 84501.

## GLOSSARY FOR GEOLOGY SECTION 3.1

**Anticline**[1]: Strata which dip in opposite directions from a common ridge or axis, like the roof of a house.

**Coal rider seam**: A thin, uneconomical coal seam that exists in the immediate roof strata overlying mineable coal seams. This seam may be separate from the main seam or a "split" that leaves the main coal seam to "ride" over the mining horizon. These seams are generally weak and are commonly the source of roof instabilities.

**Cretaceous Period**[1]: The third and final period of the Mesozoic Era which, in geologic time, falls just before the current Cenozoic Era, and covers the span of time between 135 and 65 million years ago.

**Development mining**: Preliminary entry drivage to define a large block of coal for full-extraction mining. In longwall mining, gate road, mains, and bleeder entries are considered part development mining. In full-extraction room-and-pillar mining, all mining prior to pillar retreat is considered development work, including mains and panel entry drivages.

**Dikes—igneous and clastic**[1]: A discordant tabular body of igneous rock that was injected

## REFERENCES FOR GEOLOGY SECTION 3.1

Doelling, H.H., 1972. Central Utah Coalfields: Sevier-Sanpete, Wasatch Plateau, Book Cliffs, and Emery. Utah Geological and Mineralogical Survey, affiliated with The College of Mines and Mineral Industries,

into a fissure when molten, or rock fragments (clastic material) that have been extruded along a pre-existing failure plane or zone of weakness, cutting across the structure of the adjacent country rock or sediments, and which usually has a high angle of dip.

**Escarpment**[1]: A cliff or relatively steep slope separating level or gently sloping tracts.

**Fault**[1]: A fracture or a fracture zone along which there has been displacement of the two sides relative to one another parallel to the fracture. A "normal" fault is a tensional feature where the overlying block ("hanging wall") slides down the fracture plane relative to the underlying block ("footwall"). A "reverse" or "thrust" fault is a compressional feature in which the hanging wall moves up and over the footwall along the fracture plane. A "strike-slip" fault is one in which the footwall and hanging wall block move horizontally, relative to one another, along the strike of the fracture plane.

**Fluvial**[1]: Of or pertaining to streams and rivers; produced by stream or river action, such as a fluvial plain (comprised of sand and gravel).

**Friable**[1]: Easy to break, or crumbling naturally. Used to describe weakly cemented rocks.

**Graben**[1]: A depressed segment of the earth's crust bounded on at least two sides by faults, and generally of considerable length as compared to its width.

**Impermeable**[1]: Having a texture that does not permit water to move through it perceptibly under the head differences ordinarily found in subsurface water. Those rocks which prevent further descent of surface water.

**Lacustrine deposit**[1]: Deposits which have been accumulated in freshwater lakes and marshes.

**Lenticular sandstones**[1]: Sandstone deposits that thin outward from the center, assuming a double convex lense shape.

**Lineament**[1]: A significant line of landscape that reveals the hidden architecture of the rock basement. A topographic line that is structurally controlled.

**Overburden**: The entire volume of rock strata and soil overlying the working coal seam.

**Rock Spar**[1]: Material filling fracture cleavages in coal, consisting of nonclay material, probably deposited from solution, and sand.

**Sandstone Channels**[1]: Also known as paleochannels, sand channels are essentially buried stream channels. These structures commonly reside in the immediate roof and floor strata of many western U.S. coal operations, and can create serious roof instabilities.

**Scours**: Areas of the coal seam that have been eroded away by an overlying depositional feature, commonly sandstone channels.

**Strand plain**[2]: A prograded shore built seaward by waves and currents, and continuous for some distance along the coast.

**Stress regime**: The state of in situ regional stress acting across a given property or area. Compressional or extensional (tensional) regimes refer to the types of tectonic (crustal) forces acting on an area. For example, normal faulting is commonly associated with tensional stress regimes, whereas thrust faulting is the result of a compressional stress environment.

**Subsidence**[1]: The lowering of the strata overlying a mine excavation due to the removal of the seam.

**Sympathetic faulting**: Subsidiary faulting and fracturing associated with a major fault or graben feature.

**Syncline**[1]: A fold in rocks that dip inward from both sides toward the axis. Opposite of anticline.

**Tectonic**[1]: Pertaining to rock structures and topographic features resulting from deformation of the earth's crust. Tectonic stresses are those in situ stresses resulting from large-scale strata deformation over a region (as opposed to local, mining-induced stresses).

**Tertiary Period**[1]: The earliest period in the Cenozoic Era, immediately following the Cretaceous Period in the Mesozoic Era, and covering the span of time between 65 and 3 to 2 million years ago.

**Untimely Subsidence**: Pertaining to delayed subsidence resulting from strong strata within the overburden that do not readily cave or deform.

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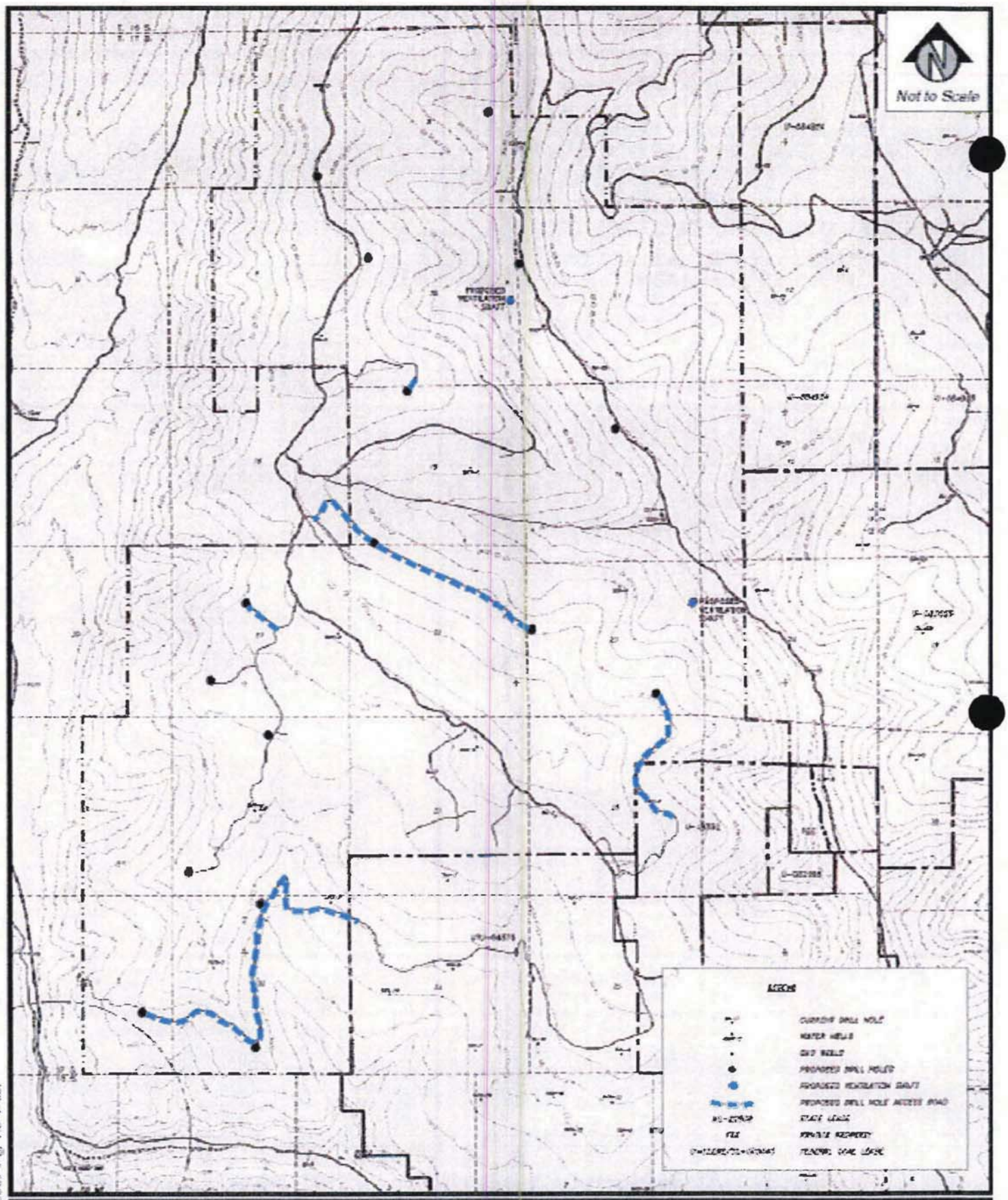
[1]U.S. Bureau of Mines, 1968. A Dictionary of Mining, Mineral, and Related Terms. USDOI, Bureau of Mines, 1968, U.S. Government Printing Office, Washington, D.C., 20402.

[2]Bates, R.L. and J.A. Jackson, 1980. Glossary of Geology. American Geological Institute, 5205 Leesburg Pike, Falls Church, VA, 22041.




**SOURCE**

*Energy West Mining Company, May 22, 1998*

**Cottonwood Lease Tract EIS**
**Proposed Exploratory Holes and Ventilation Shafts Locations**

| | | |
|---|---|---|
| EWMC0001 | DAVID EVANS AND ASSOCIATES, INC. | FIG. 1.3-1 |
| May 1999 | | Sheet 1 of 1 |

File: Drafting/8-1ew/EWMC0001-Fig 1.3-1.dgn

## 3.2 SEISMICITY

### 3.2.1 Executive Summary

Both naturally occurring and mining-induced seismic activity may be expected to occur across the Cottonwood Lease Tract throughout mining. Natural seismicity in the region stems from several large fault systems along the interior and western boundaries of the Wasatch Plateau and the San Rafael Swell to the east, and locally within the Joes Valley Fault system (bounding the western edge of the proposed lease). To date, only one large event has resulted in damage to the surrounding countryside and Joes Valley Reservoir Dam—an $M_L$ 5.3 Richter event in August, 1988, near Clawson, in Emery County (San Rafael Swell region). Although such naturally occurring events remain possible within the region, the Joes Valley Fault system is not considered "prestressed," and the potential for a large earthquake along this structure is highly unlikely.

Mining-induced seismicity, on the other hand, accounts for a majority of the measurable seismic activity in the Wasatch Plateau and Book Cliffs coalfields, with most events registering magnitudes less than $M_L$ 1.0 (Arabasz, 1997). Events greater than $M_L$ 3.0 are rare, with no mining-induced events greater than $M_L$ 3.8 ever recorded in this coal mining region. The largest mining-related seismic events in the Wasatch Plateau and Book Cliffs coalfields occurring between July 1962 (first longwall mining in the region) and March 1996 are summarized in Table 3.2-1. The table shows that out of thousands of recordable events, only 38 were of any significance ($M_L \geq 3.0$), with the largest mining-induced event ($M_L$=3.8) occurring 17 years ago on May 14, 1981, in the Gentry Mountain area several miles north of the Trail Mountain Mine (Taylor, 1994).

The primary issues impacting the Cottonwood Lease Tract, relative to seismicity, include potential damage to surface structures—including natural landforms, habitats, and manmade constructions—with a focus on the Joes Valley Dam.

The study area primarily involves the Wasatch Plateau and Book Cliffs coalfields of central Utah, focusing on the East Mountain and Trail Mountain mining areas immediate to Cottonwood Canyon. Seismic data throughout the Utah seismic belt have been utilized to develop the case history base for maximum event occurrences along known fault scarps and related degrees of surface damage. Seismicity for the central Utah coal mining district has also been characterized to evaluate the frequency and magnitude of events associated with longwall mining. Ground motion relationships associated with the Solvay Mine collapse, near Green River, Wyoming, were also used in the analyses as the only available methodology to relate event magnitude and distance to peak-particle velocities (PPVs) for mining-scale events. All of the site calculations for ground motions are specific to the lease tract and immediately adjoining areas; however, the relationship used for PPV is also applicable to the assessment of dam stability (see the Joes Valley Dam and Reservoir, Section 3.4).

The overall methodology employed in the assessment of seismic impacts to the Cottonwood Lease Tract involved a review and compilation of case history experience in the Wasatch Plateau and Book Cliffs coalfields and an empirical evaluation of potential ground motions and related levels of damage accompanying mining-induced events. Recommendations have been provided for improving the ground motion determinations through the development of a site-specific relationship for PPV, event magnitude, and distance, as well as the development of a dam stability criterion and an appropriate maximum credible event (MCE) for the local mining region. These developments are necessary to determine the potential for mining on the Cottonwood Lease Tract to damage surface structures, including the Joes Valley Dam.

**Environmental Consequences.** To date, no documented cases of seismic damage to surface structures, escarpments, dams, buildings, powerlines, roadways, slopes, embankments, ponds, habitats, etc., have been recorded in the central Utah coal mining district as a result of mining-induced events. Damage to landforms, civil constructions, and wildlife habitats and waterways have all been the result of naturally occurring earthquakes—none of which created serious failures. The relatively low magnitude events anticipated to be initiated by mining should not impact any natural or manmade surface features throughout mining (with the possible exception of the Joes Valley Dam), based on

historical experience within the mining region and empirical relationships between event magnitude, distance from the source and peak ground motions (McGarr, 1981). Concerns regarding the potential impacts to the Joes Valley Reservoir Dam, located immediately southwest of the lease, do not appear to be supported by local case history experience. However, general ground motion assessments from prior large-scale mining-induced events (Swanson and Boler, 1995) and surface blasting studies (Dowding, 1992) suggest that while intact rock failures immediate to the dam abutment are not likely, PPVs resulting from repeated mining-induced events may be sufficient to impact the current dam structure (see the Joes Valley Reservoir and Dam, Section 3.4, concerning dam stability criterion development).

## 3.3 SUBSIDENCE

### 3.3.1 Executive Summary

The study area for subsidence due to underground mining on the Cottonwood Lease Tract is limited to the tract itself, and a short distance beyond the lease boundary. This distance is determined by the angle of draw (the angle measured from vertical from the excavation edge to the limit of subsidence on the surface). Any subsidence that may occur beyond the lease boundary is, therefore, a function of the position of the excavation relative to the lease boundary, the angle of draw, and the depth of cover.

**Environmental Consequences.** Subsidence on the Cottonwood Lease Tract would occur over all full-extraction areas and, depending on the limits of mining and the angle of draw, may extend beyond the lease boundary for a distance not expected to exceed 1,000 feet. Due to the limited data available, estimates of the magnitude and extent of subsidence rely heavily on case histories of subsidence from western U.S. mines, particularly PacifiCorp's East Mountain and Table Mountain properties in the Wasatch Plateau. Based on these case histories, maximum subsidence is expected to be on the order of 70% of the mining height, although maximum subsidence may be significantly less in areas where high percentages of sandstone occur in the overburden. Angles of draw are expected to vary from less than zero to 30 degrees, and for calculating setbacks from protected surface structures or features, an angle of draw between 15 and 22 degrees is appropriate.

Under Alternatives 2 and 4, there is a potential for failures of escarpments of the Castlegate sandstone in Cottonwood Canyon and limited areas of Joes Valley. Escarpments in Straight Canyon are well beyond the lease boundary and are unlikely to be affected. Although subsidence has the potential to change or disrupt groundwater regimes and surface streams, seeps, drainages, and stock ponds, past experience on adjacent properties indicate that this potential is low.

Absent escarpment setbacks, subsidence could damage the existing road and pipeline in Cottonwood Canyon. Any power lines, fences, and survey monuments within the angle of draw of fully extracted areas may also be damaged.

**Areas of Controversy and Issues to be Resolved.** Under Alternatives 2 and 4, the potential exists for failures of escarpments of the Castlegate Sandstone, primarily in Cottonwood Canyon. To assess the hazard that this escarpment failure may pose to the public, the potential for failed escarpment material to reach National Forest Road 040 through Cottonwood Canyon should be assessed.

**Unavoidable Adverse Effects.** Unavoidable impacts due to subsidence should be limited to infrequent, isolated, and minor rock falls from escarpments.

**Mitigation Measures.** To protect surface features such as escarpments of the Castlegate sandstone, full-extraction mining should not be allowed beyond a setback determined by a 22-degree angle of draw. Development only (non-caving) mining can be practiced beyond this limit, but pillars should be of such dimension that safety factors of at least 1.5 are maintained. Under Alternatives 2 and 4, subsidence is expected to damage the gas pipeline in Cottonwood Canyon, requiring that either the pipeline be moved or that full-extraction setbacks from the pipeline be observed. Assuming that setbacks are adopted to protect escarpments, no major structures or features are known to exist that may be affected by full-extraction mining. If minor roads, power lines, structures, or survey monuments exist in areas affected by full-extraction mining, it is anticipated that they could be easily repaired or replaced should they be damaged.

**Cumulative Impacts.** Cumulative impacts may result from interaction with subsidence zones from the existing Trail Mountain Mine. However, this possible interaction would only result in impacts similar to those described for the Cottonwood Lease Tract itself. The proposed action's contribution of impacts, when added to the past, present, and future actions identified by the Forest Service, would not be significant.

### 3.3.2 Introduction

The study area for subsidence due to underground mining on the Cottonwood Lease Tract is limited to the tract itself, and a short distance beyond the lease boundary. This distance is determined by the angle of draw (the angle measured from vertical from the excavation edge to the limit of subsidence on the surface). Any subsidence that may occur beyond the lease boundary is, therefore, a function of the position of the excavation relative to the lease boundary, the angle of draw, and the depth of cover. Regardless, the maximum distance beyond the lease boundary that subsidence may be detected is on the order of 1,000 feet.

Data provided to evaluate the magnitude and extent of subsidence, and its impacts, has been limited to maps showing the general area with topography and overburden contours, outcrops of the Castlegate sandstone and proposed setbacks, areas of limited mining potential due to geologic conditions (the Mill Fork and Roan's Canyon Fault Grabens), existing roads, gas lines, gas wells, drill hole locations, major geologic structures, and raptor nesting areas. In addition, lithologic logs from eight boreholes located on the tract (boreholes TM-3 and TMTN-2 through TMTN-8) were provided. Other basic information, such as a general mining plan, seam thickness data, and physical properties of overburden strata, were not available. To estimate the magnitude and extent of subsidence, generalized mine plans were developed for Alternatives 2 through 4, with full extraction mining assumed wherever possible. Areas that cannot be fully extracted (due to mining constraints or the application of a stipulation) are assumed to have extraction ratios and pillar stabilities such that no measurable subsidence would occur.

Commonly applied subsidence prediction methods were considered to determine the likely magnitude and extent of surface subsidence due to mining of the Cottonwood Lease Tract. These methods include analytical methods (profile and influence function methods), numerical methods (boundary-element, finite-element, and distinct-element numerical modeling methods), and empirical methods (British National Coal Board Subsidence Engineers Handbook) and case histories. The influence function method was used to generate subsidence and horizontal strain curves for various cover depths to generally define the extent and magnitude of subsidence. However, due to the lack of data, the evaluation of subsidence and its impacts necessarily relies heavily on case histories of subsidence from western U.S. mines, particularly PacifiCorp's East Mountain and Table Mountain properties in the Wasatch Plateau.

### 3.3.3 Affected Environment

Underground coal mining has been performed in the area of the Cottonwood Lease Tract, including production from the nearby Deer Creek, Cottonwood, Wilberg, Deseret, Beehive, Little Dove, and American Fuel mines, and from the adjacent Trail Mountain Mine (Fry, 1998). Subsidence has occurred over these mines, but has not affected the Cottonwood Lease Tract.

Cover depth and mining height affect the extent and magnitude of subsidence. Cover over much of the Cottonwood Lease Tract exceeds 2,000 feet, and ranges from about 600 to 2,800 feet. The Hiawatha Seam is of minable coal height (>5 feet) over the entire tract, although this is the only information on seam thickness that has been provided. No other seams of minable thickness occur, and no previous mining has been performed.

The Joes Valley Dam and Reservoir is located approximately 2,000 feet southwest of the southwest corner of the tract; access to this recreation area is by State Highway 29 through Straight Canyon, which parallels the southern border of the tract. The cliff-forming Castlegate sandstone runs through the northeast corner and portions of the western border of the tract. Cottonwood Creek, an ephemeral drainage, runs through Cottonwood Canyon. No perennial streams exist on the tract, although several springs and stock ponds are present. Traces of the Mill Fork and Roan's Canyon Fault Grabens, trend roughly N45E, through the center of the Cottonwood Lease Tract. The other major geologic features within or near the lease area are the Joes Valley Fault, which is just outside the western border of the lease, and the Straight Canyon Syncline, the axis of which is parallel to and about 2,000 feet south of the Roan's Canyon Fault Graben. Five gas wells and a gas pipeline are present in Cottonwood Canyon. No significant surface structures are present within the lease boundary, although wire fence lines are present.

## Table 3.3-1:
## Summary of Western U.S. Subsidence Case Histories

| Mine | Reference | Approx. Excavated Area (feet) | Depth (feet) | Strata | Measured subsidence/ mining height | Angle of Draw | Comments |
|---|---|---|---|---|---|---|---|
| Geneva/Book Cliffs, UT | Dunrud, 1976 | Extraction widths of 1,700 ft and 2,500 ft separated by a barrier | 900 | Strong sandstones alternating with weak shales and mudstones | Not measured | Nearly vertical | Tension cracks in massive sandstone<br>Cracks up to 3-ft-wide observed in strong massive sandstone. Surface and ground water flows disrupted. |
| Somerset, CO | Dunrud, 1976 | 2000 by 2,000 | 300-1,600 ft | Mudstone and shale with sandstone beds | 0.31 | 20 degrees in weak overburden 600-900 ft deep, 15 deg in stronger overburden 900 ft deep | Tension cracks, up to 1-ft wide, appeared 2 to 4 months after mining in mudstone-sandstone overburden 500-600 ft thick. Subsidence appeared to be complete 1.5 years after mining under 300-470 ft of cover. |
| Roadside, CO | Magers, 1993 | a) 1,200 by 1,400<br>b) 700 by 1,300<br>c) 450 by 1,600 | a) 200<br>b) 50-200<br>c) 350-700 | Shale, weak sandstone, and unconsolidated till | a) 0.43<br>b) 0.06<br>c) 0.32 | a) 11 to 14 degrees<br>b) n/a<br>c) 0.32 | Partial extraction room-and-pillar; 20-ft-wide stumps left in areas "a" and "c", retreat not complete in area "b." Tension cracks visible on the surface over area "a." |
| Castlegate No. 3 | Fejes, 1986 | 1,100 by 1,900 | 800 to 1,500 | Sandstone, shale, carb. shale, coal. | 0.37 | Not given | Massive Castlegate sandstone 500 ft thick 50 ft above longwall panels may have resulted in low subsidence factor. |
| Deer Creek/Wilberg | Dyni, 1991<br>Allgaier, 1982, 1988 | 2,200 by 3,800 | 1,530 to 1,600 | Sandstone (45%), siltstone, and mudstone. | Deer Creek 0.68<br>Wilberg 0.73 | Deer Creek 30 degrees<br>Wilberg 30 degrees | Castlegate sandstone 200 ft thick, 880 ft above study panels. Deer Creek panels mined first, then undermined by Wilber panels 50 ft below. Undermining increased subsidence factor, but had no effect on angle of draw. No surface damage observed. |

**Table 3.3-2:**
**Predicted and Observed Subsidence, and Angles of Draw for East Mountain and Trail Mountain Properties, as Reported by PacifiCorp**

| Area | Subsidence | | | Angle of draw (degrees) |
|---|---|---|---|---|
| | Predicted by NCB methods (feet) | Observed (feet) | Ratio of observed to predicted | |
| Deer Creek 9th East, Wilberg 1st Right | 15.2 | 28.0 | 1.82 | NR |
| Deer Creek 5th-8th East, Wilberg 3rd-13th Right | 13.8 | 13.1 | 0.95 | 30 |
| Deer Creek 1st North | 7.7 | 5.5 | 0.71 | NR |
| Deer Creek 2nd-17th Right | 13.6 | 13.5 | 0.99 | <0-22 |
| Deer Creek 2nd-5th Left | 13.5 | 12.5 | 0.93 | 0-13 |
| Wilberg 1st-2nd Left | 5.0 | 4.5 | 0.90 | NR |
| Beehive 2nd North | 6.6 | 7.4 | 1.12 | NR |
| Beehive 3rd-8th West and 3rd-9th East, Deseret 3rd-9th West and 1st-5th East | 6.8 | 4.8 | 1.04 | 31 |
| Little Dove 1st North | 4.3 | 3.5 | 0.81 | NR |
| Old American Fuel | 7.0 | 6.1 | 0.87 | NR |
| Deer Creek C and D North, Cottonwood 6th, 7th, and 11th Right | 13.7 | 13.2 | 0.96 | <0-28 |
| Wilberg 2nd left | 1.5 | 0.0 | 0.00 | N/A |
| Des-Bee-Dove Southern Areas | 2.0 | 1.8 | 0.90 | NR |
| Cottonwood 6th-7th East | 7.6 | 4.7 | 0.62 | 25 |
| Cottonwood 9th-12th West | 7.2 | 5.0 | 0.69 | 0-20 |
| Cottonwood 8th-11th East | 7.4 | 4.5 | 0.61 | NR |
| Cottonwood 15th-16th West | 8.1 | 7.2 | 0.89 | <10 |
| Deer Creek 2nd-7th Right | 7.7 | 7.2 | 0.94 | NR |
| Deer Creek 7th-8th East | 7.9 | 4.5 | 0.57 | NR |
| Deer Creek 1st-2nd Left | 7.8 | 6.1 | 0.79 | >10 |
| Deer Creek 2nd-7th East | 7.5 | 7.5 | 1.00 | 0 |
| Deer Creek 2nd-8th West | 7.5 | 8.1 | 1.08 | NR |
| Trail Mountain 2nd-5th East | 7.8 | 8.1 | 1.04 | NR |
| Trail Mountain 1st-10th Right | 7.5 | 2.1 | 0.94 | NR |

Notes:

NR: Not recorded.

N/A: Not applicable.

Source: Fry, 1998

**Table 3.3-3:**
**Maximum Ground Movement Associated with Various Overburden Compositions for the Example Extraction Geometry**

| Percent Sandstone | Subsidence (S) (feet) | Horizontal Displacement (U) (feet) | Slope (I) (ft/ft) | Horizontal Strain (ε) (in/in) | Curvature (k) ($ft^{-1}$) |
|---|---|---|---|---|---|
| 30 | 6.1 | 2.0 | $5.9 \times 10^{-3}$ | $2.9 \times 10^{-3}$ | $9.4 \times 10^{-6}$ |
| 50 | 4.0 | 1.3 | $3.9 \times 10^{-3}$ | $1.9 \times 10^{-3}$ | $6.2 \times 10^{-6}$ |
| 70 | 2.4 | 0.8 | $2.4 \times 10^{-3}$ | $1.2 \times 10^{-3}$ | $3.8 \times 10^{-6}$ |

**Table 3.3-4:**
**Subsidence Damage Criteria**

| Structure or Feature | Damage Severity | Type of Movement | Suggested Limit | Potential for Impact on Cottonwood Tract if not Mitigated |
|---|---|---|---|---|
| Roads | Architectural (minor surface or pavement cracking) | Horizontal Strain | $1.0 \times 10^{-3}$ | High |
| | | Slope | $5.0 \times 10^{-3}$ | Moderate |
| | Functional (undulations and water accumulation) | Slope | $5.0 \times 10^{-3}$ | Moderate |
| | Structural (adverse effects on driving dynamics) | Slope | $10.0 \times 10^{-3}$ | Low |
| Pipelines | Severe (failure of pipes or couplings) | Horizontal Strain | $1.0 \times 10^{-3}$ | High |
| Woodland, range, or wildlife food and cover | Severe (loss of use) | Horizontal Strain | $5.0 \times 10^{-3}$ | Low |
| | | Slope | $300 \times 10^{-3}$ | Low |
| Streams and ponds | Severe (partial or complete loss of water) | Horizontal Strain | $5.0 \times 10^{-3}$ | Low |

**Note: If setbacks from escarpments of the Castlegate sandstone are observed, potential for each impact is low.**

Source: Singh, 1992.

## 3.5 SOILS

### 3.5.1 Executive Summary

Soils within the lease area vary widely across the landscape in terms of physical and chemical characteristics. Parent materials are primarily sedimentary in origin, ranging from limestones to shales, and occur on uplands with slope angles of from 5 to 80 percent. Alluvial and colluvial parent materials underlie valley bottom and fan positions on slopes of 30 percent or less. Moderately deep to deep, well drained soils are the norm, though more shallow soils can be found associated with steeper mountain sideslopes. Soil textures are highly variable. Coarse fragment contents (by volume) are similarly diverse, typically ranging from 15 to 70 percent with content generally increasing with depth. Values for pH predominantly range from 6.5 to 8.5. Erosion hazards range from "low" to "high" with "moderate" to "high" ratings most common. Surface soils typically have "moderate" revegetation potentials with the depth of salvage most often constrained by high subsurface coarse fragment content.

**Areas of Controversy and Issues to be Resolved.** There are no significant areas of controversy or issues to be resolved with respect to soils.

**Environmental Consequences.** The main concern with respect to soils is the potential for slope failures at escarpment formations and other steeply sloping areas. The potential for subsidence is also an issue, as is the potential for soil erosion during drill pad and ventilation shaft construction, and the early stages of site revegetation. Given the limited surface area proposed for disturbance under any of the alternatives, the potential impacts to soils are not considered to be significant.

The Special Coal Lease Stipulations will require adequate stabilization of soils and reestablishment of disturbed soil productivity.

**Unavoidable Adverse Effects.** No unavoidable significant adverse impacts are likely to occur in association with the soil resource. Impacts which would occur are limited primarily to the surface soil materials which typically have fair to high revegetation potentials.

**Mitigation Measures.** Basic revegetation techniques, from soil reapplication to mulching, applied properly, should lead to successful revegetation and restoration of the productivity of the affected soils. Special lease stipulations and site-specific stipulations for coal drilling permits provide numerous requirements to mitigate soil impacts.

**Cumulative Impacts.** The Cottonwood Lease area consists of approximately 9,244 acres. Past surficial disturbances include 9 acres associated with coal mining, 28 acres associated with exploration drilling along with 12 miles of temporary roads, and 6 acres related to gas well development. Past escarpment failures total slightly in excess of 40 acres. All but 4 acres of exploration drill pads and 2.3 miles of associated roads have been successfully reclaimed. The acreage affected by the escarpment failure is considered by the agencies to be natural looking and no mitigation is planned for this disturbance.

A high potential for oil and gas development in the area has been predicted and the Forest Service has assumed that approximately 6 acres of surficial disturbances would occur in the next 15 years as a result. The acreage of soils proposed to be affected by any coal leasing action alternative totals approximately 19 acres. The total acreage of future disturbances (25 acres) represents a doubling of the acreage disturbed by past mining efforts, but is a negligible percentage (0.003%) with respect to the lease area as a whole.

## 3.5.2 Introduction

An Order III soil survey was completed for the Manti-La Sal National Forest and a draft report prepared in 1995 (Larsen, 1995). The report consisted primarily of soil map unit descriptions, typical pedon descriptions, interpretive data, and a survey map depicting map unit boundaries at a scale of 1:24,000. The report was reviewed by agency personnel, revisions made, and a second draft report issued containing updated soil information. The second report, *Soil Resource Inventory of the Manti Division Manti-La Sal National Forest, Utah* (Larsen, 1997), was used herein to describe the soils overlying the lease area and to assess the potential impacts to the soil resource. No site-specific soil baseline studies were conducted for the lease area as a part of this project.

To initiate this project, existing soil survey information was requested from various sources. A contact was made with a representative of the Natural Resources Conservation Service (NRCS) (Sasser, 1998) to determine whether this agency had conducted any soil surveys within the lease area. Given that the entire lease area is managed by the USDA, Forest Service, no surveys had been performed by the NRCS. Concurrently, the document titled *Cottonwood Canyon Tract Lease-By-Application No. 8 (UTU-68012)* (PacifiCorp/ Energy West Mining Company, 1997) was reviewed. It was found that this document contained soils information for only a portion of the proposed lease area. Additional soils information (the baseline soil survey from which the Applicant had developed the lease area report cited above) for the entire lease area was obtained from the Manti-La Sal National Forest. A copy of the revised baseline soil survey (Larsen, 1997), including a soil map of the proposed lease area, was used in this analysis.

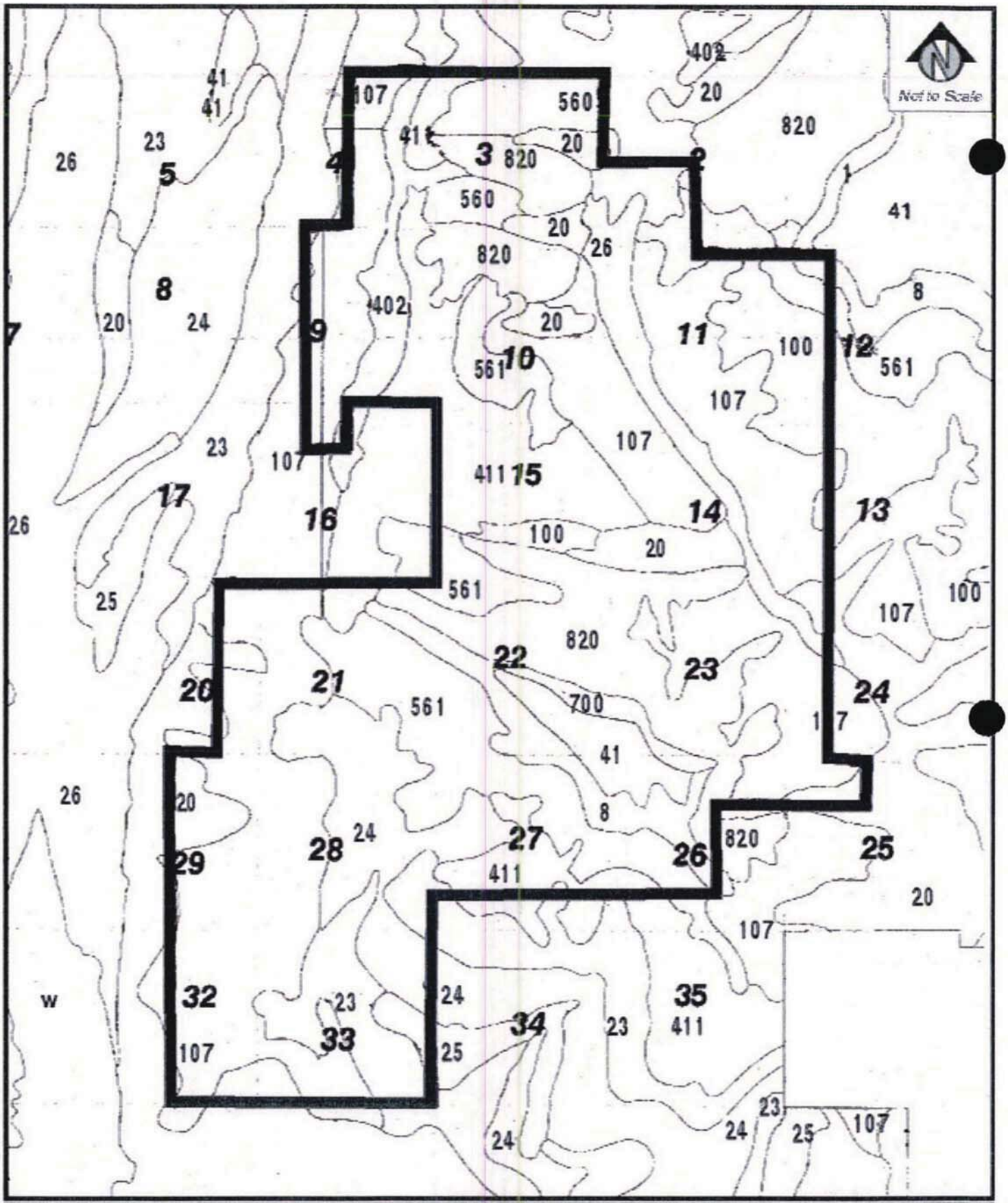
The proposed development plans for the lease area were reviewed to assess, initially, the potential impacts to the soils of the project area. The proposal includes construction of two ventilation shafts and 16 drill pads. No new road construction is planned though small road spurs may be necessary to access some drill pads. Given this limited level of proposed disturbance, it was determined that the main issues with respect to the soils discipline would include the potential for slope failures at escarpment formations and other steeply sloping areas, as well as subsidence. The revegetation potentials of the soils to be disturbed would also be of concern with respect to decreasing soil erosion and site stabilization potentials.

## 3.5.3 Affected Environment

### *3.5.3.1 General Soil Characteristics and Erosion Hazards*

A total of 15 soil map units, characterized by 23 soil families and four miscellaneous groupings, were delineated within the lease area at the Order III level (Larsen, 1997). These soils are forming in response to the wide variety of parent materials, elevations, slopes, aspects, and rates of material weathering common to the lease area as a whole. Consequently, these soils exhibit a wide variety of characteristics in terms of soil chemical and physical properties. Figure 3.5-1, Soil Type Designation, depicts the 15 soil map units delineated. Table 3.5-1, Soil Characteristics Summary, presents edaphic data for selected parameters having a bearing on the salvage suitability of the dominant soils mapped as well as erosion hazard ratings assigned and primary limitations to map unit revegetation.

Soils overlying mountain sideslopes and associated landforms are developing in limestone, sandstone, and shale parent materials. These soils occur on slopes ranging from 5 to 80 percent and




**SOURCE**

*Manti - La Sal National Forest, undated.*

**Cottonwood Lease Tract EIS**
**Soil Type Designation**

| | | |
|---|---|---|
| EWMC0001 | DAVID EVANS AND ASSOCIATES, INC. | FIG. 3.5-1 |
| May 1999 | | Sheet 1 of 1 |

Ref: Drafting/gdb-1/ew/EWMC0001-Fig 3.5-1.dgn

are typically moderately deep to very deep, well to somewhat excessively drained, and have "moderate" available water capacities. The erosion hazard ranges from "low" to "high" but is typically "moderate" to "high" for the majority of these soils. Soil textures are highly variable ranging from loams to very cobbly loams for surface soils and from sandy loams to extremely stony clay loams for subsurface soil horizons. Coarse fragment contents (by volume) are similarly variable ranging from less than 15 to 40 percent and from less than 15 to 70 percent for surface and subsurface soils, respectively. The pH values of these soils are typically above 6.5 to 7.0, though values as low as 5.6 occur infrequently. The primary limitations to map unit revegetation include steep slopes and slope instability.

Sandstone and shale parent materials overlying slopes ranging from 20 to 80 percent dominate the canyon, escarpment, and associated landform soils of the lease area. These soils are shallow to very deep, well drained, and typically exhibit "moderate" available water capacities. Erosion hazards are rated as "moderate" to "high." Textures range from sandy loams and loams to very stony loams throughout the profile. Coarse fragment contents of surface soil horizons are typically less than 25 to 30 percent while subsurface horizons commonly exhibit percentages exceeding 50 percent. The pH values of these soils range from 5.2 to 9.0, though values above 7.0 predominate. Steep slopes and droughty soils are the major constraints to revegetation of these units.

Soils overlying ridges and associated mountainsides are forming in limestone, shale, and sandstone parent materials on slopes ranging from 5 to 60 percent. The depth, drainage, and available water capacity characteristics of these soils are similar to those overlying canyon and escarpment landforms. Erosion hazards vary from "low" to "high". Surface soil textures range from loams and clay loams to gravelly loams with coarse fragment contents rarely exceeding 25 percent. Subsoil textures range from clay loams to very cobbly clay loams with coarse fragment contents highly variable. The pH values vary from 6.6 to 8.2. Steep slopes and shallow soils limit the revegetation potentials of these units.

Shallow to very deep, well drained soils with "low" to "moderate" available water capacities typify the ridges, benches, and plateaus of the lease area. Limestone and shale are the dominant parent materials underlying slopes ranging from 5 to 60 percent. The erosion hazards are typically rated as "low" to "moderate." Surface soil textures range from loams to gravelly sandy loams while subsoil textures range from gravelly clay loams to extremely stony clays. Coarse fragment contents vary from less than 15 percent to 65 percent throughout the profile. The pH values range from 6.4 to 8.3. Constraints limiting the revegetation potentials of these units variably include high surficial coarse fragment cover, high lime content, clayey subsoils, and steep slopes.

Soils overlying valley bottoms and fans are developing in mixed alluvial and colluvial parent materials. These soils occur on slopes of 30 percent or less and are typically very deep and well drained with "moderate" to "high" available water capacities. The erosion hazard ranges from "low" to "moderate." Soil textures typically range from sandy clay loams and loams to very cobbly clay loams with coarse fragment contents typically ranging from less than 15 to 60 percent, increasing with depth. The pH values of these soils typically exceed 7.8. The main limitation to map unit revegetation is the potential for droughty soil conditions.

No prime farmland soils occur within the lease area.

#### *3.5.3.2 Soil Salvage and Reclamation Suitability*

Table 3.5-2, Surficial Salvage Depths, presents the depths to which soils of the lease area are suitable for salvage. These depths were selected considering the limited disturbances proposed

Table 3.5-2

while assuming that the unsalvaged subsoils remain in place and would be available as a subgrade growth medium following facility decommissioning. Map unit slopes were not considered since the range of slopes within a map unit often includes slope angles both accessible and inaccessible to salvage equipment.

A single depth or a depth range is presented for each map unit component depending upon subsoil characteristics. A depth range is indicative of transitional subsoils which would allow a deeper salvage depth considering the potential for soil blending during salvage. Limitations to deeper salvage are also presented for each map unit component, as is descriptive information regarding soil map unit component landscape positions (Larsen, 1997).

The soils overlying the project area exhibit a comparatively narrow range of characteristics with respect to salvage suitability. Proposed total salvage depths typically range from 6 to 18 inches and include both surface and subsurface soil materials. The main constraint to deeper soil salvage across the lease area is high subsoil coarse fragment content (>35% by volume). Low pH values (<6.5), clayey subsoils, high free lime contents, and shallow depths to bedrock also constrain salvage depth for a number of units.

### 3.5.4 Environmental Consequences

The criteria used to evaluate impacts relate primarily to soils having high slope failure and erosion potentials. The primary factor which would contribute to a significant soil impact in this regard is a slope angle equal to or greater than 3.0H to 1.0V. Map units 8, 560, and 700 as well as portions of other map units with slope angles exceeding approximately 33 percent are of particular concern.

Where impacts to the soil resources would occur, the evaluation criteria center upon mitigation measures used to stabilize disturbed areas during operations and to revegetate such areas following facility closure. Revegetation techniques and methodologies exist whereby disturbances such as those planned can be successfully reclaimed. Mitigation which incorporates such techniques as soil salvage and reapplication, fertilization, seeding/planting with adapted species, and mulching would have a high potential for revegetation success with respect to the types of impacts likely to occur. Mitigation which would provide for soil stability and a likely return of soil productivity to 90 percent of the pre-disturbance levels within 3 to 5 years following seeding would be considered successful in terms of these evaluation criteria and in accordance with Forest Service stipulations for coal drilling permits. Characteristics of note with respect to determining the erosion and revegetation potentials of soils include slope angles, soil depth and textures (as related to water holding capacity, drainage, and infiltration), soil profile coarse fragment contents, pH, lime content, and electrical conductivity (in mmhos/cm) where known.

## Table 3.5-1:
## Soil Characteristics Summary

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] | Primary Map Unit Revegetation Limitations |
|---|---|---|---|---|---|---|---|
| **Map Units of Mountain Sideslopes and Associated Landforms** | | | | | | | |
| 8 (30-80) | | | | | | | |
| Greyback (40) | Slopes & benches | Mod. deep | cosicl/vcosicl-xstcl | 30/70 | 7.6/7.5-7.8 | H | Steep slopes, rapid |
| Cryorthents (20) | Slopes | Varies | sl-c/sl-c | 5-65 | Varies | H | runoff, landslides |
| Echard (20) | Slopes | Deep+ | sicl/c | <15/<15 | 7.5/7.6-7.7 | M | |
| 25 (5-30) | | | | | | | |
| Doney (30) | Slopes | Mod. deep | l-stl/l | <15-20/<15 | 8.4-8.6/8.6-9.0 | M | High surface coarse |
| Allens Park (30) | Benches & slopes | Mod. deep | cl-scl/cl-cosl | <15/<15-30 | 7.8-8.0/8.0-8.3 | M | fragments, droughty |
| Repp (25) | Ridges & slopes | Mod .deep/deep | scl/vgrscl | <15/40-60 | 8.0/8.0 | M-H | |
| 100 (30-70) | | | | | | | |
| Gralic (40) | Ridges & slopes | Deep+ | grsl/vcosl | 20/50-55 | 6.4/6.7-8.0 | L-M | Steep slopes |
| Behanin (25) | Slopes | Deep | l/vstl-xstcl | <15/55-65+ | 7.0/7.0-7.8 | M | |
| Elwood (20) | Slopes | Deep+ | vstl-vcocl/xcol-vcosl | 35-40/25-60 | 6.4-6.6/6.0-6.2 | H | |
| 560 (5-50) | | | | | | | |
| Clayburn (45) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | M | Slope instability |
| Greyback(45) | Slopes | Mod. deep | cosicl/vcosicl-xstcl | 30/70 | 7.6/7.5-7.8 | M | |
| 700 (30-80) | | | | | | | |
| Pachic Cryoborolls (35) | Slopes | Deep | sic/grsic-vgrc | 5-15/30-55 | 7.2-7.5/7.4-7.9 | M-H | Steep slopes, clay |
| Typic Cryoborolls (25) | Slopes | Deep | cocl/vcocl-vcoc | 25-35/25-40 | 7.8/8.0 | M-H | textures, landslides |
| 820 (30-70) | | | | | | | |
| Lucky Star (50) | Slopes | Deep+ | l-col/vcosl-vcocl | 10-20/55-60 | 6.0-6.2/5.6-6.0 | M | Steep slopes |
| Bundo (25) | Slopes | Deep + | grsl-vgrsl/vgrsl-xcosl | 25/50-65 | 5.8-6.2/5.6-5.8 | M | |
| Adel (20) | Short slopes | Deep+ | l/l-grsil | <15/<15 | 6.0/5.6-6.0 | H | |

**Table 3.5-1:**
**Continued**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] | Primary Map Unit Revegetation Limitations |
|---|---|---|---|---|---|---|---|
| **Map Units of Canyon Slopes, Escarpments, and Associated Mountain Slopes** | | | | | | | |
| 20 (30-80) | | | | | | | |
| Strych(30) | Slopes | Deep+ | sl-grsl/vgr-vcosl | <15-25/50-55 | 8.2/8.4 | M-H | Steep slopes, low |
| Pathead (30) | Slopes | Deep+ | col/vco-vstl | 30/45-60 | 7.2/7.2-8.4 | M-H | available water ca- |
| Podo (15) | Slopes & benches | Shallow | l-grsl | 10-25 | 8.2 | M-H | pacity, cliffs, |
| Rubbleland (15) | Slopes | Varies | Varies | Varies | Varies | Varies | stoniness |
| 107 (20-70) | | | | | | | |
| Scout (35) | Slopes | Deep+ | sl/sl-vgrsl | <15/<15-65 | 5.2/5.2-5.5 | H | Steep slopes, |
| Doney (25) | Slopes | Mod. deep | l-stl/l | <15-20/<15 | 8.4-8.6/8.6-9.0 | H | droughty soils |
| Guben (25) | Slopes & draws | Deep+ | sci-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | H | |
| **Map Units of Ridges and Associated Mountainsides** | | | | | | | |
| 23 (20-60) | | | | | | | |
| Ridge (40) | Ridges | Shallow | grl-cl | <25 | No info. | H | Steep slopes, shallow |
| Guben (30) | Slopes & fans | Deep+ | sci-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | H | soils, droughty |
| Podo (20) | Slopes | Shallow | l-grsl | 10-25 | 8.2 | M-H | |
| 561 (5-40) | | | | | | | |
| Clayburn (55) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | L-M | Moderately steep |
| Faim (20) | Ridges & slopes | Deep+ | cl/cl-c | <15/<15 | 6.6/6.8-8.2 | L-M | slopes |
| Behanin (15) | Slopes | Deep | l/vstl-xstcl | <15/55-65+ | 7.0/7.0-7.8 | L-M | |
| **Map Units of Ridges, Benches,and Plateaus** | | | | | | | |
| 24 (5-30) | | | | | | | |
| Rabbitex (45) | Fans & slopes | Deep+ | l-cl/cl-grcl | <15/10-25 | 8.2-8.3/8.2-8.3 | H | High CaCo3 content, |
| Repp (33) | Ridges & slopes | Mod. deep/Deep | scl/vgrscl | <15/40-60 | 8.0/8.0 | M-H | surface coarse frag. |
| 41 (2-15) | | | | | | | |
| Castino (90) | Ridge tops | Mod. deep | cl/xstc | <15/65 | 7.0-7.2/6.8-7.6 | L | Clayey soils |

**Table 3.5-1:**
**Continued**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Soil Depth[1] | Surface/ Subsoil Textures[2] | Surface/ Subsoil Coarse Frag. (%) | Surface/ Subsoil pH | Erosion Hazard[3] | Primary Map Unit Revegetation Limitations |
|---|---|---|---|---|---|---|---|
| **Map Units of Ridges, Benches,and Plateaus(Continued)** | | | | | | | |
| 402 (8-60) | | | | | | | |
| Roxal (40) | Ridgetops | Shallow | cl/cl | <15/20 | 6.8/6.8 | M | Steep slopes, high |
| Merino (25) | Ridges & slopes | Shallow | vcol/vcol | 35/60 | 6.8/6.8 | M | surface coarse |
| Gralic (20) | Ridges & slopes | Deep+ | grsl/vcosl | 20/50-55 | 6.4/6.7-8.0 | L-M | fragments, droughty |
| 411 (5-30) | | | | | | | |
| Clayburn (55) | Ridges & slopes | Deep+ | l/cl-vcol | <15/<15-35 | 7.2/7.0-8.0 | L-M | |
| Faim (30) | Ridges & slopes | Deep+ | cl/cl-c | <15/<15 | 6.6/6.8-8.2 | M | |
| **Map Units of Valley Bottoms and Fans** | | | | | | | |
| 26 (0-30) | | | | | | | |
| Gubin | Slopes & fans | Deep+ | scl-vgrcl/cl-vcocl | 5-40/10-60 | 7.8/8.0-8.2 | M | Droughty |
| Rabbitex | Fans & slopes | Deep+ | l-cl/cl-grcl | <15/10-25 | 8.2-8.3/8.2-8.3 | L-M | |

[1] Deep = 40-60+", Moderately deep = 20-40", Shallow = <20"

[42] Modifiers: gr = gravelly, vgr = very gravelly, exgr = extremely gravelly, co = cobbly, vco = very cobbly, exco = extremely cobbly, st = stony, vst = very stony, exst = extremely stony; textures: s = sand, ls = loamy sand, sl = sandy loam, l = loam, si = silt, sil = silt loam, scl = sandy clay loam, cl = clay loam, sicl = silty clay loam, sc = sandy clay, sic = silty clay, c = clay.

[3] L= Low; M = Moderate; H = High

## Table 3.5-2:
## Surficial Salvage Depths

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Primary Surficial Salvage Depth (in.) | Primary Salvage Depth Limitation (s) |
|---|---|---|---|
| 8 (30-80) | | | |
| Greyback (40) | Slopes & benches | 12 | High coarse fragment content |
| Cryorthents (20) | Very steep slopes | Variable | Variable |
| Echard (20) | Slopes | 12 | Clay texture |
| 20 (30-80) | | | |
| Strych(30) | Canyon and escarpment slopes | 12 | High coarse fragment content, mod. high pH |
| Pathead (30) | Canyon slopes | 6-12 | High coarse fragment content |
| Podo (15) | Canyon slopes | 6-11 | Bedrock, high free lime content |
| Rubbleland (15) | Slopes | Opportunistic | High coarse fragment content, bedrock |
| 23 (20-60) | | | |
| Ridge (40) | Convex ridges | 11 | Bedrock |
| Guben (30) | Convex slopes & fans | 12-18 | High coarse fragment content |
| Podo (20) | Convex slopes | 6-11 | Bedrock, high free lime content |
| 24 (5-30) | | | |
| Rabbitex (45) | Convex or flat fans & slopes | 12 | High free lime content |
| Repp (33) | Convex slopes | 12 | High coarse fragment content |
| 25 (5-30) | | | |
| Doney (30) | Complex slopes | 12-18 | High free lime content, mod. high pH |
| Allens Park (30) | Complex benches & slopes | 12-20 | High free lime content, mod. high pH |
| Repp (25) | Complex slopes | 12 | High coarse fragment content |
| 26 (0-30) | | | |
| Gubin | Valley bottoms & fans | 12 | High coarse fragment content |
| Rabbitex | Valley bottoms & fans | 12 | High free lime content |
| 41 (2-15) | | | |
| Castino (90) | Convex slopes | 12 | High coarse fragment content |
| 100 (30-70) | | | |
| Gralic (40) | Long convex slopes | 6-12 | High coarse fragment content |
| Behanin (25) | Convex slopes | 12 | High coarse fragment content |
| Elwood (20) | Concave slopes | 12 | Low pH values, high co. frag. content |
| 107 (20-70) | | | |
| Scout (35) | North-facing slopes | 0 | Low pH values throughout profile |
| Doney (25) | Mountain slopes | 12-18 | High lime content, mod. high pH |
| Guben (25) | Mountain slopes & draws | 12 | High coarse fragment content |

**Table 3.5-2 (continued)**

| Map Unit # & Slope (%)/ Components (%) | Landform or Location | Primary Surficial Salvage Depth (in.) | Primary Salvage Depth Limitation (s) |
|---|---|---|---|
| 402 (8-60) | | | |
| Roxal (40) | Convex ridgetops | 6-17 | Bedrock |
| Merino (25) | Convex ridges & slopes | 6-12 | Bedrock, High coarse fragment content |
| Gralic (20) | Slopes below ridgetops | 6-12 | High coarse fragment content |
| 411 (5-30) | | | |
| Clayburn (55) | Gentle to moderate slopes | 12-30 | High coarse fragment content |
| Faim (30) | Mountain slopes | 12-18 | Clay textures |
| 560 (5-50) | | | |
| Clayburn (45) | Short convex slopes | 12-30 | High coarse fragment content |
| Greyback(45) | Convex mountain slopes | 12 | High coarse fragment & free lime content |
| 561 (5-40) | | | |
| Clayburn (55) | Convex slopes | 12-30 | High coarse fragment content |
| Faim (20) | Concave slopes | 12-18 | Clay textures |
| Behanin (15) | Convex slopes | 12 | High coarse fragment content |
| 700 (30-80) | | | |
| Pachic Cryoborolls (35) | Mountain slopes | 12-18 | High coarse fragment content |
| Typic Cryoborolls (25) | Mountain slopes | 12 | High coarse fragment content |
| 820 (30-70) | | | |
| Lucky Star (50) | Mountain slopes | 6-12 | High coarse fragment content, low pH |
| Bundo (25) | Concave lopes | 6 | High coarse fragment content, low pH |
| Adel (20) | Short south-facing slopes | 12-24 | Low pH values |

## 3.6 GROUNDWATER

### 3.6.1 Executive Summary

Specific environmental concerns regarding underground coal mining in the Cottonwood Coal Lease Tract include impacts to ground-water systems overlying and underlying the mined horizon, impacts to groundwater systems related to the Joes Valley Fault, diversion of water from Joes Valley Reservoir, the rate of discharge from mine workings to the surface, transbasinal diversions, degradation of water in the mine environment, and water rights infringements.

**Environmental Consequences.** This environmental analysis concluded that there should be no impacts to groundwater systems in the Cottonwood Tract, except that mining would dewater the Spring Canyon Member of the Star Point Sandstone. Because water in the Spring Canyon Member has antiquity and does not support groundwater discharge where exposed south of the Cottonwood Tract, the dewatering of this system would be an inconsequential environmental impact.

Hydraulic communication is not thought to exist between Joes Valley Reservoir and the Hiawatha Coal Seam in the Cottonwood Tract, nor should mining induce hydraulic communication. Therefore, diversion of water from Joes Valley Reservoir is not expected.

A reasonable estimate of discharge from mine workings in the Cottonwood Tract is 400 to 800 gpm. Because mining removes water from inactive groundwater systems, transbasinal diversions would be inconsequential.

Adverse impacts to the quality of water that passes through the mine environment are not expected. Acid mine drainage is not a problem in the region because of abundant naturally-occurring carbonate minerals that neutralize acid produced by the oxidation of sulfide minerals, and because of the low sulfur content of coal in the tract. If ferrous material and equipment were abandoned in the mine, the material should not impact water quality.

Because adverse impacts to groundwater systems or diversion of water from Joes Valley Reservoir are not expected, water rights associated with springs or water in the reservoir should not be affected.

The proposed action is consistent with the goal of the Forest Land and Resource Management Plan to provide favorable conditions of water flow (quality and quantity).

**Areas of Controversy and Issues to be Resolved.** There are no significant areas of controversy or issues to be resolved regarding the proposed action's potential impacts to groundwater resources.

**Mitigation Measures.** No additional mitigation beyond that provided by BLM Standard Lease conditions and Special Coal Lease stipulations is required.

**Unavoidable Adverse Effects.** The dewatering of the Spring Canyon Member of the Star Point Sandstone could be an unavoidable impact. Because the Spring Canyon Member does not support active groundwater flow or support significant groundwater discharge relative to discharge from active groundwater systems that occur near the surface, the dewatering of this system would not be significant.

**Cumulative Impacts.** Mining at the Trail Mountain mine is currently dewatering the Spring Canyon Member of the Star Point Sandstone. Mining in the Cottonwood Tract would continue to dewater the Spring Canyon Member. No other activity listed in the Forest Service table of past, present, and future actions are affecting groundwater in the Spring Canyon Member. Therefore, the proposed action would not contribute to any other cumulative groundwater impact.

### 3.6.2 Introduction

Because mining can impact groundwater resources beyond tract boundaries, this analysis discusses potential impacts to groundwater resources within Trail Mountain. This area is bounded by Cottonwood Canyon on the northeast, Joes Valley on the west, and Straight Canyon to the south.

Underground coal mining in the Cottonwood Coal Lease Tract ("Cottonwood Tract") has the potential to disrupt groundwater recharge and discharge mechanisms and flow patterns in Trail Mountian. Impacts to groundwater systems may potentially result in adverse impacts to natural groundwater discharge rates and groundwater production wells. Underground coal mining also may adversely impact groundwater quality, especially the quality of water that passes through the mine.

Possible adverse impacts to the quantity and quality of groundwater resources are, potentially, the most significant environmental consequence of underground coal mining. Impacts to groundwater systems can have secondary effects in that the disruption and degradation of groundwater affects riparian and wetlands habitat, vegetation and forage, and wildlife and stock watering supplies.

Specific environmental concerns regarding underground coal mining in the Cottonwood Tract were identified during public scoping and by Federal, State, and local entities. These issues are listed below.

**Impacts to groundwater systems overlying and underlying the coal horizon.** There are two mechanisms for adversely affecting groundwater systems in the Cottonwood Tract. First, the coal horizon and water-saturated unmined horizons immediately above and below the coal horizon are dewatered by the extraction of coal and the leakage of water from the roof and floor into mine openings. Second, longwall extraction methods cause bedrock fracturing and land subsidence above longwall panels. By potentially providing pathways for groundwater to move downward toward the mined horizon, fracturing and subsidence may divert water from saturated horizons and surface water bodies above and adjacent to caved areas. Impacts to groundwater systems potentially may result in the decrease in natural discharge rates from springs and seeps.

**Impacts to groundwater systems associated with the Joes Valley Fault System.** Although no groundwater systems have been identified that are associated with the Joes Valley Fault system, the fault system likely plays some role in the hydrogeologic regime in Trail Mountain. As mining in the Cottonwood Tract advances near the fault zone, groundwater systems associated with the fault may potentially be disrupted.

**Diversion of water from Joes Valley Reservoir.** Water may potentially be diverted from Joes Valley Reservoir if the coal horizon in the Cottonwood Tract is now in hydraulic communication with Joes Valley Reservoir or if hydraulic communication can be induced by mining-related subsidence and fracturing. If hydraulic communication exists now or might be induced, water will be diverted from the reservoir. The consequences of diversion of water from the reservoir include impacts to water rights and the need to discharge this water to a surface drainage.

**Potential mine water discharge rate.** Water that is discharged from mine workings may affect stream morphology, erosion, and riparian ecosystems in the receiving drainage. The rate at which water flows from the surrounding rock into the mine determines, in large part, the rate that water is discharged from the mine. As mining in the Trail Mountain Mine has progressed southward toward the plunging end of the Straight Canyon Syncline, the amount of water encountered underground has increased significantly. Larger quantities of water may be associated with mining in the Cottonwood Tract.

**Transbasinal diversions.** Water that is intercepted by underground mining in the Cottonwood Tract will need to be discharged to the surface by pumping or gravity drainage. Transbasinal diversion of water may potentially occur if groundwater is discharged to a surface drainage other than the drainage where the water would have discharged under natural conditions.

**Degradation of water quality in the mine environment.** The quality of water that passes through the mine environment or is exposed to waste rock from the mine may be degraded by chemical interactions with naturally occurring

minerals and materials and equipment introduced into the mine.

**Impacts to water rights.** Associated with any impact to natural groundwater flow rates or the diversion of water from Joes Valley Reservoir are impacts to appropriated water rights.

### *Methods of Analysis*

The environmental analysis presented in this technical report is based on the following assumptions:

1. The hydrogeology of the Cottonwood Tract is similar to that in the adjacent PacifiCorp lease areas on Trail and East Mountains. This assumption is reasonable because the Cottonwood Tract and the adjacent lease area share common and continuous bedrock lithologies, geologic structure, geomorphology, and climate.
2. The effects of coal mining at the existing PacifiCorp Mines on groundwater systems can be extrapolated into the Cottonwood Tract. The overburden thickness, proposed mining geometries, and proposed extraction methods for the Cottonwood Tract are similar to those at the adjacent PacifiCorp mines with the exception that two coal seams have been mined in many areas of East Mountain.

Therefore, this analysis of potential environmental impacts incorporates:

1. characterizations of the hydrogeology of the Cottonwood Tract and adjacent areas on Trail and East Mountains,
2. comparison of baseline discharge, solute, and isotopic data collected from within the Cottonwood Tract to similar data collected in adjacent areas, and
3. descriptions of mining-related impacts to other portions of the PacifiCorp lease areas.

### *Evaluation Criteria*

Impacts to groundwater resources in the analysis area would be considered significant if:

1. Natural groundwater discharge rates increase or decrease.
2. The quality of groundwater discharge is degraded.
3. The quality of water passing through the mine environment is degraded and does not meet Utah Pollutant Discharge Elimination System (UPDES) beneficial use standards.

### *Previous Investigations and Existing Data*

Several investigators have described groundwater resources in the Cottonwood Tract and adjacent areas. Groundwater systems and possible effects of underground coal mining in the Trail Mountain area are described by the United States Geological Survey (Lines, 1985). The United States Department of the Interior, Bureau of Mines (Kadnuck, 1994) investigated the response of springs to longwall coal mining above the Deer Creek and Cottonwood Mines on East Mountain. Mayo and Associates (1997) investigated surface-water and groundwater systems and described the probable hydrologic consequences of coal mining on East and Trail Mountains.

## 3.6.3 Affected Environment

### *Geologic Setting*

A brief discussion of the water-bearing and water-transmitting properties of the bedrock formations in the project area is included here because of the profound effect that stratigraphy has on groundwater occurrence, flow, and solute chemistry in the project area.

Seven bedrock formations crop out in the project area. In descending order these formations are the Flagstaff Limestone, North Horn Formation, Price River Formation, Castlegate Sandstone, the coal-bearing Blackhawk Formation, the Star Point Sandstone, and the Mancos Shale. These formations were deposited along the margin of the Western Interior Cretaceous Seaway. Regressions and transgressions of this seaway have resulted in a heterogeneous sequence of rock types that are both horizontally and vertically discontinuous. The heterogeneity of the rocks in the project area dictates the water-bearing and water-transmitting properties of these rocks.

The Flagstaff Limestone typically forms a prominent white cliff on top of Trail Mountain. A thickness of 105 feet was measured on Trail Mountain. The Flagstaff Limestone consists of carbonates, marls, and some thin sandstone stringers deposited in lacustrine, marginal lacustrine, and alluvial plain depositional

environments. Water is generally transmitted through fractures in the limestone.

The North Horn Formation is the caprock of much of East and Trail Mountains where the Flagstaff Limestone has been eroded away. In the Trail Mountain area, the thickness ranges from 750 to 800 feet and increases to the west. The North Horn Formation was deposited in an alluvial-plain/suspended-load fluvial channel environment. In such environments layers of mud are more abundant than sands, which occur in sandstone channels. The sandstone channels are generally isolated from each other both laterally and vertically by mud-rich overbank and interfluvial rocks. In the study area the formation consists primarily of shale with discontinuous sandstone channels, minor lenses of limestone, and conglomerate. Highly bentonitic mudstones, which swell when wetted, are common in the lower two-thirds of the formation.

The Price River Formation typically forms a steep, receding slope above the Castlegate Sandstone with alternating ledges and slopes resulting from the interbedding of resistant sandstones with less resistant shales and claystones. In the lease area the formation is 350 to 400 feet thick. This formation was deposited by fluvial systems. Mudstone drapes deposited during interfluvial periods separate fluvial sandstones from each other both horizontally and vertically. Thus, while the fluvial sandstones in the Price River Formation are capable of transmitting water, water is not transmitted any significant vertical or horizontal distance because of these mudstone drapes.

The Castlegate Sandstone has a distinctive cliff forming habit and typically forms a resistant cliff above the underlying, less resistant Blackhawk Formation. The thickness of the Castlegate Sandstone ranges from 250 to 300 feet in the area. The unit is comprised of coarse-grained, often conglomeratic, fluvial sandstone with some thin interbeds of siltstone and claystone. The Castlegate Sandstone is the product of a braided fluvial depositional system. Siltstone and claystone represent deposition during interfluvial times. Fine-grained layers and pervasive carbonate and silica cement restrict groundwater movement in the Castlegate Sandstone.

The marine Masuk Member of the Mancos Shale was deposited in an open marine The Blackhawk Formation generally forms a steep, irregular slope between the cliffs of the underlying Star Point Sandstone and the overlying Castlegate Sandstone. The formation consists of an upper non-marine, suspended-load fluvial portion and a lower marine shoreface and non-marine foreshore portion. Massive, cliff-forming units are common in the upper portion, and thinner-bedded, slope-forming units are common in the lower portion. The thickness of the Blackhawk Formation ranges from 625 to 800 feet in the area and generally thickens to the northeast. The upper portion of the Blackhawk Formation was deposited in delta and flood plain environments in which layers of mud are more abundant than channel sands. Sandstone channels are generally isolated from each other both laterally and vertically by mud-rich overbank and interfluvial rocks. The lower portion of the Blackhawk Formation contains the mineable coal deposits and consists of more thinly bedded sandstone and shale layers. The coal-bearing units of the lower Blackhawk Formation overlie and are laterally juxtaposed to marine shoreface sandstones of the Blackhawk Formation and Star Point Sandstone. On a large scale, these sandstone bodies are laterally continuous but terminate abruptly into the mud- and organic-rich backshore faces in a landward direction. However, individual rock layers are lenticular and discontinuous, with abundant shaley interbeds. The fine- to medium-grained sandstones occur as thin- to massively-bedded paleochannel deposits. The paleochannels increase in frequency, thickness, and lateral extent upward in the formation. Shales in the Blackhawk Formation commonly contain swelling clays that when wetted, swell to seal any natural or induced fractures.

Mining in the Cottonwood Tract would occur in the Hiawatha coal seam of the Blackhawk Formation. This coal seam occurs near the bottom of the Blackhawk Formation and, in the Trail Mountain area, is separated from the underlying Star Point Sandstone by 20 to 30 feet of shaley lagoonal deposits.

The Star Point Sandstone, which is present throughout the area, forms massive cliffs where exposed at the surface. The sandstone was deposited as marine shoreface blanket sands which are laterally continuous, but thin seaward (east). Landward (west), these sandstones

terminate abruptly into the mud- and organic-rich backshore facies. Because many of the organic-rich facies have been converted to mineable quality coal, locally the Star Point Sandstone has immediate contact with coal seams. Elsewhere sandstone bodies of the Star Point Sandstone are overlain and underlain by lower shoreface deposits or open marine shales of the Mancos Shale. This means that the marine shoreface sandstones are three dimensionally encased by low-permeability marine shales and fine-grained carbonaceous backshore coal-bearing facies. The Star Point Sandstone thins eastward and merges with the underlying Masuk Member of the Mancos Shale. Three prominent tongues of the Star Point Sandstone interfinger with the Mancos Shale. These three sandstone members, from top to bottom, are the Spring Canyon, Storrs, and Panther Sandstones. In the lease area, the Spring Canyon tongue is approximately 100 feet thick, lies about 80 feet above the Storrs tongue, and consists of massive, fine- to medium-grained sandstone. The Storrs tongue lies about 120 feet above the Panther tongue and consists of 50 feet of soft, friable sandstone. The basal Panther tongue is approximately 100 feet thick and consists of massive, crossbedded delta front sandstones.

The marine Masuk Member of the Mancos Shale was deposited in an open marine environment. The rock is highly erodeable calcareous, gypsiferous, and carbonaceous dark gray shale. It is continuously exposed along the eastern edge of the Wasatch Plateau. The Masuk member is approximately 1,300 feet thick. Westward thinning wedges of the Masuk interfinger with tongues of the Star Point Sandstone. Castle Valley, to the east of the study area, is developed on the Mancos Shale. This thick sequence of impermeable rock has poor water-transmitting potential.

In Trail Mountain, the dip of the bedrock is controlled primarily by the Straight Canyon Syncline, which runs diagonally through the middle of the mountain, trending approximately north 50° east and plunging to the southwest. Bedrock located northwest of the syncline axis generally dips toward the southeast, whereas bedrock located southeast of the syncline axis dips toward the northwest. The dips of the rocks throughout the study are gentle, rarely exceeding 6°.

Most faults in the study area trend north-south or northeast-southwest. The most significant is the Joes Valley Fault System, which extends more than 20 miles to the north and 40 miles to the south of the Joes Valley Reservoir, and has over 2,000 feet of vertical displacement. Joes Valley is a graben (valley) formed on the downthrown block west of the fault. Much of Joes Valley is filled with alluvium that is juxtaposed against the bedrock formations of Trail Mountain.

The Mill Fork and Roan's Canyon Fault systems, which have much less displacement than the Joes Valley System, form narrow grabens in the central portion of Trail Mountain. The Mill Fork and Roan's Canyon Fault systems roughly parallel the Straight Canyon Syncline and appear to be scissor faults hinged near the center of Trail Mountain. At the hinge location there is essentially no vertical or horizontal displacement. Maximum displacement on these faults in the lease area is estimated to be 30 feet on the Mill Fork Fault, and 160 feet on the Roan's Canyon Fault.

### *Groundwater Systems*

The notion of a groundwater system is useful to discuss the dynamics of groundwater recharge, flow, and discharge in areas such as Trail Mountain. In areas such as these, groundwater commonly occurs in localized areas. Aquifers, in the traditional sense, do not exist. (An aquifer is often thought of as a geologic unit that can store and transmit water at rates fast enough to supply reasonable amounts to wells). A groundwater system may be thought of as groundwater which 1) flows through one or more rock units or structures which have similar hydraulic characteristics, and 2) has similar recharge mechanisms, flow patterns, and discharge mechanisms. This definition does not imply or require that groundwater in a particular groundwater system has hydraulic continuity with all other groundwater in that system.

Four distinct types of groundwater systems exist or are suspected to exist in Trail Mountain. These systems are:

- Alluvial groundwater systems in Cottonwood Canyon
- Perched groundwater systems in the bedrock formations overlying the Hiawatha coal seam

- Confined groundwater system(s) in the Spring Canyon Member of the Star Point Sandstone underlying the Hiawatha seam
- Fault-related groundwater systems (possibly may exist)

These types of systems are described below.

**Alluvial Groundwater Systems.** PacifiCorp (1994) carried out a detailed hydrogeologic investigation of the alluvium that occurs in Cottonwood Canyon. The maximum alluvial thickness in the canyon bottom ranges from 40 to 70 feet. The alluvial sediments consist primarily of lateral and terminal glacial moraine deposits. Below the northwest corner of section 24 T17S R6E, the alluvial deposits are fluvial in origin. Nested monitoring wells were installed in both the alluvium in Cottonwood Canyon and in the underlying Spring Canyon member of the Star Point Sandstone. Time-dependant water level data from these wells indicate that groundwater in the alluvial deposits respond to seasonal variations in precipitation while groundwater in the underlying Star Point Sandstone does not respond to seasonal variations. This indicates that groundwaters in the alluvial deposits are hydraulically isolated from groundwaters in the underlying Spring Canyon sandstone. Springs discharging near the base of Cottonwood Canyon (e.g., Roan's Canyon Spring, Cottonwood Spring) are fed by shallow alluvial systems and are not related to bedrock groundwater systems in the Star Point Sandstone. Unstable isotopic data from Roan's Spring, which discharges from the alluvial groundwater system in Cottonwood Canyon indicates that the water is of modern origin and is not related to the deep groundwater systems encountered within the mines.

**Perched Groundwater Systems.** Perched groundwater systems occur in each of the bedrock formations overlying the Hiawatha seam except the Flagstaff Limestone. These systems support both active and inactive groundwater flow. Active groundwater flow decreases dramatically with depth and distance from canyon walls. This is indicated by the number of springs that discharge from each formation.

Springs do not issue from the Flagstaff Limestone on Trail Mountain because of the limited areal extent of the unit due to erosion.

The North Horn Formation is the caprock of nearly the entire surface of Trail Mountain. Consequently, the formation supports over 70% of the springs that have been identified on Trail Mountain (PacifiCorp, 1997). Groundwater systems in the North Horn Formation support active groundwater flow as indicated by seasonal and climatic spring discharge rate fluctuations and anthropogenic $^{14}C$ and abundant tritium contents (Mayo and Associates, 1997).

Mayo and Associates (1997) report that two types of groundwater issue from the North Horn Formation. The more predominant of the two waters is a $Ca^{2+}$-$Mg^{2+}$-$HCO_3$ type water with low total dissolved solids (TDS). The second is a $Ca^{2+}$-$HCO_3$-$SO_4^{2-}$ type water that has elevated TDS and elevated $Ca^{2+}$ and $SO_4^{2-}$ concentrations. The elevated solute concentrations are interpreted to result from the dissolution of gypsum. Groundwaters with elevated $SO_4^{2-}$ contents issue from two sections of the North Horn Formation (within 50 feet of the base of the North Horn and between 550 and 600 feet from the base of the formation). Low $SO_4^{2-}$ groundwaters discharge from springs located stratigraphically throughout the formation including from the two sections identified above. The distribution of elevated $SO_4^{2-}$ groundwaters means that flow paths within the North Horn Formation are short and there is little vertical communication of waters. If water were being communicated vertically, solute concentrations, especially $Ca^{2+}$ and $SO_4^{2-}$, would be more uniform in the formation.

Significantly less water is supported by the Price River Formation. On Trail Mountain, only seven springs have been identified that discharge from the Price River Formation. Discharge and solute data from these springs are limited. However, data from Price River Formation springs on East Mountain indicate Price River Formation groundwater systems have similar discharge characteristics as do North Horn Formation springs. Unstable isotopic data from spring 17-32-1 on Trail Mountain indicates that, although the spring has a modern $^{14}C$ age, the relatively low tritium content (2.2 TU) suggests that some groundwater systems in the Price River Formation may have longer flow paths.

A number of springs issue from the Blackhawk Formation near the Blackhawk Formation-

Castlegate Sandstone contact. Unstable isotopic data from five springs on Trail Mountain indicate that, with the exception of one spring, these springs contain anthropogenic $^{14}C$ and tritium. Spring 18-4-1, which issues at the down plunge end of the Straight Canyon syncline, has a modern $^{14}C$, but contains no tritium or anthropogenic $^{14}C$. The water discharging from this spring was recharged prior to about 1954, but no more than a few hundred years ago. Discharge data for Blackhawk Formation-Castlegate Sandstone springs are limited, but do suggest that the groundwater systems that support these springs are seasonally dependent.

Groundwater is encountered in the strata immediately overlying the Hiawatha coal seam. This groundwater occurs in relatively permeable sandstone paleochannels. These sandstone channels are encased by mostly impermeable shales and mudstones that hydraulically isolate groundwater in the sandstone from groundwaters occurring in other sandstone channels. When saturated sandstone channels are encountered by mining they yield water for a short period of time (days to several months, depending on the size of the channel). In the Trail Mountain Mine, groundwater inflows from strata overlying the mine are inconsequential because sandstone channels do not occur immediately above the Hiawatha coal seam, as they do in other locations, but occur higher in the section than the coal seam. Unstable isotopic data from roof drips in the Trail Mountain Mine and elsewhere in the Wasatch Plateau indicate that water in sandstone paleochannels is thousands of years old and contains no tritium. This indicates that these groundwaters are not part of an active groundwater flow system and do not support significant groundwater discharge relative to discharge from active groundwater systems that occur near the surface.

**Confined Groundwater System in the Star Point Sandstone.** The Trail Mountain Mine currently is receiving diffuse inflows of water from the mine floor. This water most likely upwells from the underlying Spring Canyon Member of the Star Point Sandstone. Water upwells into the mine floor only in the western section of the mine where mining has advanced downward into the eastern limb of the Straight Canyon syncline. That water upwells into the mine floor indicates that 1) water in the Spring Canyon Member is confined and 2) the elevation of mine workings in the western portion of the mine are below the elevation of the local potentiometric surface in the Spring Canyon Member. That the Hiawatha coal seam does not support water indicates that, under natural conditions, groundwater does not upwell from the Spring Canyon Member into the Blackhawk Formation and, conversely, the Spring Canyon Member is not being recharged by the downward migration of water from overlying strata. The diffuse character of the upwelling further supports the idea that water does not naturally upwell from the Spring Canyon Member into the Blackhawk Formation. The interburden between the Spring Canyon Member and the Hiawatha coal seam has a low enough hydraulic conductivity to only support diffuse groundwater flow despite artesian pressure on the system. That these rocks are transmitting any water is likely a result of fracturing in the underburden due to stress unloading as coal is removed.

Groundwater monitoring well TM-3 is located in Straight Canyon less than 0.5 miles south of the Trail Mountain lease. When first completed in September 1993, the well flowed freely at the surface. For several years thereafter, the well maintained a constant shut-in pressure of 64 psi (which equates to a piezometric level approximately 150 feet above ground surface). Beginning in early 1997, the piezometric level in this well began falling dramatically. At about this same time groundwater began to be encountered in the floor of the mine. Thus the piezometric decline in TM-3 is most likely in response to mining and the depressurization of the groundwater system in the Spring Canyon Member.

It is difficult to quantify the amount of water upwelling into the mine from the Spring Canyon Member. Water is pumped from the Trail Mountain Mine at a rate of 200 to 300 gpm of water about half of the time. Water is also used in-mine as process water, shipped out with the coal, or lost to evaporation. It is estimated that the amount of inflow is roughly 100 to 200 gpm. That the decline in the potentiometric level at TM-3 has been so large (200 feet within the first four months), while only relatively small amounts of water have been extracted from the Star Point Sandstone, suggests that the areal extent of the impacted groundwater system is relatively small or that the volume of water in storage is small. The rapid decline also indicates that groundwater in the Spring Canyon Member is not likely in good hydraulic communication with

recharge areas (i.e. the surface or Joes Valley Reservoir).

Mayo and Associates (1997) report that groundwater from well TM-3 has a radiocarbon age of 6,000 years meaning that groundwater flow in the Spring Canyon Member is inactive. Because of the antiquity of the groundwater, it is reasonable to assume that the natural discharge rate of this groundwater system is small (several gpm). However, the natural discharge location of water in this system has not been identified. No springs issue where the Spring Canyon Member crops out in Straight Canyon.

Lines (1985) stated that most of the Blackhawk Formation and Star Point Sandstone in the Trail Mountain area are saturated and comprise the Blackhawk-Star Point aquifer, which, he postulated, extends throughout most of the Wasatch Plateau coal field. Experience has shown that this aquifer does not exist. No mine workings in the Wasatch Plateau have encountered fully saturated Blackhawk Formation and the mining horizon in the Trail Mountain Mine is not saturated. Instead, groundwaters in the lower Blackhawk Formation occur primarily in discontinuous sandstone channels. It is not uncommon for some of these channels to be completely dry, while others are partially or completely filled with water. Between these sandstone channels, the surrounding shales and claystones of the Blackhawk Formation are usually dry. Although much less is known about the Star Point Sandstone, experience has shown that 1) the tongues of the Star Point Sandstone are not regionally continuous and 2) the sandstone does not support water everywhere. Where water is encountered in the Star Point Sandstone, it is generally thousands of years old.

**Fault-Related Groundwater Systems.** No fault-related groundwater systems have been specifically identified in Trail Mountain. However, the Cottonwood Tract is dissected by the Roan's Canyon and Mill Fork fault systems and is bounded to the west by the Joes Valley Fault system. There is adequate reason to suspect that some or all of these structures may support groundwater systems. The Roan's Canyon fault system was the source of large groundwater inflow to the Deer Creek Mine. The Mill Fork fault system has never been encountered by mining. Experience with the Joes Valley Fault system in other areas has shown that the fault system supports groundwater flow. However, the dynamics of groundwater flow in fault systems in the Wasatch Plateau is not well understood.

PacifiCorp has investigated the dynamics of groundwater flow along the Roan's Canyon fault system. A series of horizontal drill holes constructed from within the mine intercepted the fault. Limited lateral hydraulic communication along the fault system was suggested by the fact that discharge from drill holes located only 200 feet apart did not significantly affect the discharge rates of other individual holes. When the mine workings encountered the fault, the maximum rate of groundwater inflow to the Deer Creek Mine was estimated to be greater than 5,000 gpm. This inflow gradually declined and was last estimated at less than 150 gpm. It is possible that this large groundwater inflow emanated from a sandstone channel that was intercepted by the fault and was able to store a large quantity of water. This suggests that much less water may be supported elsewhere along the Roan's Canyon fault system. Groundwater in the Roan's Canyon fault system had a radiocarbon age of 12,000 years (Mayo and Associates, 1997). This indicates that the groundwater in the Roan's Canyon fault system was not part of an active groundwater flow system as it was probably not supporting significant groundwater discharge to the surface.

Groundwater from the Roan's Canyon fault was also encountered with a series of test wells including TW-10, a 1,100-foot-long horizontal hole drilled into the fault system in the Deer Creek Mine. It was apparent during drilling that groundwater issuing from TW-10 was from a sandstone channel that had been highly fractured. Ubiquitous iron oxide in the fractured sandstone indicated that water in the fracture had been in good communication with atmospheric gases. Although TW-10 is under considerable cover (1,200 feet), it is located near the cliff faces. The cliff face rocks are extremely fractured and open to recharge water. The average temperature of groundwater from TW-10 is 7.7°C while the average temperature of other groundwaters in the Deer Creek Mine is 11.8°C. The cooler temperature of water from TW-10 relative to other in-mine groundwaters is attributed to the location of TW-10 near cliff faces. This indicates that near cliff face exposures of faults, they may support active groundwater flow.

The Joes Valley Fault system has been encountered in the workings of the Crandall Canyon Mine in East

Mountain several miles north of the Cottonwood Tract. Water upwells from the floor of the mine at the fault and does not appear to be under great confining pressure (Mayo and Associates, 1997b). Unstable isotopic analysis indicates that the water has a radiocarbon age of 2,000 years and contains no tritium indicating that this water is not part of an active groundwater flow system.

## REFERENCES FOR GROUNDWATER SECTION 3.6

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Mayo and Associates, 1997a, Investigation of surface-water and groundwater systems in the PacifiCorp Lease Area, East and Trail Mountains, Emery County, Utah: Probable hydrologic consequences of coal mining in the Trail Mountain LBA and Recommendations for surface-water and groundwater monitoring. Unpublished consulting report, 20 October 1997, Lindon, Utah.

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NSA Engineering, Inc., 1998, Subsidence Analysis for Cottonwood Coal Lease Tract EIS.

PacifiCorp, 1994, Cottonwood Canyon Creek 1992 Hydrogeologic Investigation.

## 3.7 SURFACE WATER

### 3.7.1 Executive Summary

The analysis of surface water hydrology includes streams, ponds, and area drainages. The analysis does not consider riparian habitat (discussed in the vegetation section), or springs and seeps (discussed in the groundwater section). The study area for surface water hydrology includes the region bounded by the area of potential subsidence (please see Subsidence, Section 3.3) to the north, Straight Canyon to the south, Cottonwood Canyon and the area of potential subsidence on the east, and Joes Valley to the west. The study area is shown on Figure 3.7-1. The Cottonwood Lease Tract area lies entirely within the Cottonwood Creek drainage basin. No perennial streams exist on the lease tract.

**Areas of Controversy and Issues to be Resolved.** There are no significant areas of controversy or issues to be resolved for surface water.

**Environmental Consequences.** Mining-induced subsidence can cause total or partial loss of surface water resources including stream flows and lake and pond levels. Minor potential impacts from mining activities include increased erosion and sedimentation from surface disturbances and water quality degradation from mine water discharge or accidental spills.

The proposed mining area for all action alternatives is beyond any expected angle of draw of subsidence to perennial streams or lakes, therefore, no significant impacts to surface water resources from subsidence are expected. Minor subsidence-induced impacts could occur to certain reaches of ephemeral and intermittent drainages or ponds directly above or within the angle of draw of the underground mining. The areas of potential subsidence for the three action alternatives are shown on Figures 3.3-5 through 3.3-7.

It is important to note that no disruptions of surface water resources have been observed during mining of PacifiCorp properties in the area in over sixteen years of records. Based on previous experience in the Wasatch Plateau, single-seam-longwall mining under drainages where 600 or more feet of overburden is present has not manifested noticeable effects on the surface (Sidle, 1995). Cover in the Cottonwood Lease Tract ranges from 600 to 2,800 feet and usually exceeds 2,000 feet. Historical evidence shows that surface water impacts from mining are unlikely.

## 3.7.2 Introduction

The study area for surface water hydrology includes the region generally bounded by the area of potential subsidence (a maximum of approximately 1,000 feet from tract boundary, defined in the Subsidence Section) to the north, Straight Canyon to the south, Cottonwood Canyon and the area of potential subsidence on the east, and Joes Valley to the west.

The analysis of surface water hydrology includes streams, ponds, and area drainages. The analysis does not consider riparian habitat (discussed in Vegetation, Section 3.9), or springs and seeps (discussed in the Groundwater section). Perennial streams are defined as flowing year round from source to mouth. Intermittent streams flow during runoff and in reaches that receive flow from springs, and are usually dry by late summer and early fall. Ephemeral streams only flow as a direct response to snow melt or storm events.

The criteria for significant impacts refers to adverse impacts to the quality or quantity of perennial streams, reservoirs, and surface water rights. Insignificant impacts are those related to ephemeral drainages, intermittent streams, and ponds.

Information for this evaluation was derived from the following sources:

- Water quality and quantity data for area drainages: PacifiCorp, U.S. Geological Survey (USGS), and Bureau of Reclamation (BOR).
- Water quality and quantity data for the Trail Mountain Mine discharge, PacifiCorp.
- Water rights information within a one-mile radius from the proposed Cottonwood Lease Tract, Utah Department of Natural Resources (UDNR), Division of Water Rights.
- Subsidence impact analysis, NSA Engineering (NSA).
- Review of various PacifiCorp consultant reports related to surface water hydrology.
- Information from NEPA documents from nearby development proposals.
- Review of maps by the USGS, U.S. Forest Service (Forest Service), Bureau of Land Management (BLM), and PacifiCorp.
- Correspondence with team members including the Forest Service.

## 3.7.3 Affected Environment

The Cottonwood Lease Tract is located in central Utah in the Wasatch Plateau Known Recoverable Coal Resource Area (as delineated in Round II of the Uinta-Southwestern Utah Regional Coal EIS, BLM, 1983). The surface resources of the lease area are administered by the Manti-La Sal National Forest and the coal resources are administered by the BLM. The Cottonwood Lease Tract is located immediately west of the existing Trail Mountain Mine (operated by PacifiCorp/Energy West). The most economical and likely mining scenario for the Cottonwood Lease Tract is by access through the existing Trail Mountain Mine complex (USFS, 1998a). This scenario would require minimal surface disturbance consisting of two ventilation shafts, 16 exploration drill hole pads, and access roads to these sites (for a total area of disturbance of 19 acres).

The Cottonwood Lease Tract area lies within the Cottonwood Creek drainage basin, a tributary to the San Rafael River. The San Rafael River is tributary to the Green River, a major tributary of the Colorado River. The headwaters of Cottonwood Creek are located on East Mountain in the Wasatch Plateau. Cottonwood Creek within Cottonwood Canyon, upstream of the confluence with Straight Canyon Creek, is known as Cottonwood Canyon Creek. Cottonwood Creek flows southeastward approximately 25 miles to its confluence with the San Rafael River.

Water in the Cottonwood Creek drainage basin above Castle Valley is primarily used for stock watering and industrial purposes including coal mining and electrical power generation. Within Castle Valley, agricultural and industrial usage utilize most of the water, with minor amounts used by the small municipality of Orangeville, Utah. In addition, transbasin diversions occur throughout the area (PacifiCorp, 1997a and Mundorff, 1980).

Surface drainages within or adjacent to the Cottonwood Lease Tract are separated into three separate areas: Joes Valley, Straight Canyon, and Cottonwood Canyon. The Joes Valley area includes portions of Indian Creek, Lowry Water, Reynolds Canyon, and Sportsman Lodge Canyon. Straight Canyon includes four unnamed drainages, USFS codes 305, 410, 201, and 303. The western side (lease tract side) of Cottonwood Canyon includes Winks Canyon, Dairy Canyon, South Dairy Canyon, Indian Lodge Canyon, Trail Canyon, Mine Site

drainage, and South Mine Site drainage. The east side of Cottonwood Canyon includes Marinus Canyon, Mill Canyon, Roan's Canyon, and Flag Lake Canyon. PacifiCorp completed a detailed stream study as part of the data adequacy requirements for the Cottonwood Canyon Tract Lease By Application (PacifiCorp, 1997a). Much of the following information was derived from that study. Table 3.7-1 summarizes the area drainage characteristics. Figure 3.7-1 shows the drainages, springs, ponds, and surface water monitoring stations.

Outside the Cottonwood Lease Tract, portions of lower Indian Creek, Lowry Water, and all of Straight Canyon are perennial. Indian Creek and Lowry Water are ephemeral in their upper reaches (USFS, 1997). Cottonwood Canyon Creek is ephemeral in its upper reaches and intermittent in its lower reaches to its confluence with Straight Canyon (Mayo and Associates, 1997). The remaining drainages are ephemeral or intermittent (PacifiCorp, 1997a).

Joes Valley Reservoir is a major surface water body located in Joes Valley southwest of the lease area. The reservoir was completed in 1965 by the Bureau of Reclamation (BOR) and has a drainage area of 146 square miles with a usable capacity of 54,610 acre-feet. The reservoir is the main feature of the Emery County Project, part of the Colorado River Storage Project (USFS, 1971). It is used for recreation and storage for irrigation and industrial purposes (BOR, 1998).

### *Area Drainages*

The watershed above Joes Valley Reservoir is known as the Straight Canyon Barometer Watershed (USFS, 1971). The watershed comprises 93,567 acres and includes three subwatersheds: North Dragon Creek, Seely Creek, and Lowry Water. Numerous studies have been completed on the Straight Canyon Barometer Watershed to assist in the planning of water yield improvement management programs (USFS, 1971 and 1997).

**Joes Valley Area.** Indian Creek drains Upper Joes Valley to its confluence with Lowry Water, which then flows into Joes Valley Reservoir. This drainage is outside and directly west of the Cottonwood Lease area. Indian Creek is ephemeral in its upper reaches and becomes perennial in Section 34, T15S R6E (USFS, 1997). Several small unnamed ephemeral drainages, originating from the lease area, drain to Indian Creek (T17S R6E, Sections 4, 9, and 16).

Lowry Water drains Upper Joes Valley, joins with Indian Creek, and flows into Joes Valley Reservoir. The watershed area of the Lowry Water drainage, including Indian Creek, is 42,674 acres (USFS, 1988). This drainage is directly west of the Cottonwood Lease area. Several small unnamed ephemeral drainages, originating from the lease area drain to Lowry Water (T17S R6E, Sections 21, 28, and 32). The Forest Service completed a water resources inventory and analysis for the Lowry Water Drainage in 1988, part of the Straight Canyon Barometer Watershed Project (USFS, 1998). This study evaluates sediment yield, landslide susceptibility, and overall watershed condition.

Two drainages from Trail Mountain flow directly into Joes Valley Reservoir: Reynolds Canyon and Sportsman Lodge Canyon. Reynolds Canyon has intermittent flow and originates in Section 28, T17S R6E. The hydraulic length of this drainage is approximately 7,200 feet with elevations ranging from about 7,100 to 9,000 feet. The drainage area is 447 acres. Three springs (17-28-1, 2, and 3) are reported in this drainage.

Sportsman Lodge Canyon is ephemeral and originates in Section 32, T17S R6E. The hydraulic length of this drainage is approximately 5,000 feet with elevations ranging from about 7,000 to 8,600 feet. The drainage area is 383 acres. Two springs (17-32-1 and 2) are reported in this drainage.

**Straight Canyon Area.** Straight Canyon is located directly south of the Cottonwood Lease Tract. Several unnamed drainages originating from the Cottonwood Lease Tract drain to Straight Canyon. Straight Canyon flows east from Joes Valley Reservoir at the dam outlet to its confluence with Cottonwood Canyon Creek, approximately 4.5 miles downstream.

- Four drainages from the Cottonwood Lease Tract area flow into Straight Canyon. The first drainage (a.k.a. USFS 305) originates Sections 32 and 33, T17S R6E. The hydraulic length of this drainage is approximately 5,400 feet with elevations ranging from about 6,800 to 8,500 feet. The drainage area is 285 acres. One spring (18-4-1) is reported in this drainage.
- The second drainage (a.k.a. USFS 410) is intermittent and originates in T17S R6E, Sections 21, 22, 26, 27, 28, and 33. The hydraulic length of this drainage is approximately 16,400 feet with elevations ranging from about 6,700 to 9,300 feet. The drainage area is 3,303 acres. Sixteen springs are located in this drainage, including two in Section 21 (17-21-3 and 4), two in Section 22 (17-22-1 and 2), three in Section 26 (17-26-1, 2, and 3), two in section 27 (17-27-1 and 2), one in section 28 (17-28-4), five in Section 35 (17-35-1, -2, -3, -4, and -5), and one in Section 3, T18S R6E (18-3-1). Seven ponds are also located in this drainage: two in Section 35, T17S R6E, (35-1P and 2P), and one in Section 1, T18S R6E (1-1P), one in Section 28 (206040), and three in Section 27 (206001, 206021, 206006).
- The third drainage (a.k.a. USFS 201) is ephemeral and originates in Section 2, T17S R6E. The hydraulic length of this drainage is approximately 9,100 feet with elevations ranging from about 6,550 to 8,900 feet. The drainage area is 448 acres. One spring is reported in this drainage, 18-2-1.
- The fourth drainage (a.k.a. USFS 303) is intermittent and originates in Section 35, T17S R6E. The hydraulic length of this drainage is approximately 11,400 feet with elevations ranging from about 6,530 to 9,100 feet. The drainage area is 900 acres. No springs are reported in this drainage.

**Cottonwood Canyon Creek Area.** Cotton-wood Canyon Creek begins at the divide on Trail Mountain north of the lease area in Section 23, T16S R6E, at an elevation of about 10,200 feet. Cottonwood Canyon Creek flows south for a distance of approximately 12,700 feet to its confluence with Straight Canyon at an elevation of about 6,350 feet. The average gradient of this drainage is about 5.7 percent. The drainage area of Cottonwood Canyon Creek is approximately 133,120 acres. PacifiCorp has maintained four surface water monitoring stations in Cottonwood Canyon Creek since 1979, SW-1, SW-2, SW-3, and the USGS flume, CCC-01.

Upper Cottonwood Canyon Creek is ephemeral to surface monitoring station SW-1 and intermittent to its confluence with Straight Canyon. Cottonwood Creek below Straight Canyon is perennial (Mayo and Assoc., 1997). Monitoring station SW-1 is located near the lease boundary below the confluence with Trail Canyon in Section 24, T17S R6E. Measured discharge (1979 to 1997) at SW-1 ranges from 0.006 cfs (3 gpm) to 5.0 cfs (2,244 gpm) with a mean flow of 0.31 cfs (139 gpm) (PacifiCorp, 1998b). Stream flows recorded below the Trail Mountain Mine discharge points at station SW-2 (Section 25, T17S R6E) range from 0.004 cfs (2 gpm) to 3.8 cfs (1,700 gpm) with a mean of 0.35 cfs (158 gpm). Flows in Cottonwood Canyon recorded at SW-3, located above the confluence with Straight Canyon (Section 6, T17S R7E) range from 0.007 cfs (3 gpm) to 4.0 cfs (1,795 gpm) with a mean of 0.36 cfs (160 gpm). The USGS flume, CCC-01, is located between SW-2 and SW-3 (Section 31, T17S R7E). The incomplete period of record for CCC-01 is from 1979 through 1983. Flows at this station range from 0.78 cfs (352 gpm) to 6.2 cfs (2,800 gpm) with a mean of 2.65 cfs (1,188 gpm). Flow data are summarized in Table 3.7-2.

The USGS operated a gaging station in Cottonwood Creek below the confluence of Straight Canyon from 1909 to 1927, 1933 to 1970, and 1975 to 1984 (USGS, 1997b). Data from the USGS gage from 1975 to 1984 are deemed most applicable for this study (since the reservoir was constructed in 1965). During the period of record from 1975 to 1984, discharge in Cottonwood Creek ranged from less than 10 cfs (4,488 gpm) to over 2,000 cfs (897,666

gpm). The drainage area at this gaging station is 209.0 square miles (USGS, 1997b).

The following drainages within the Cottonwood Canyon Creek watershed originate within the Cottonwood Lease Tract (west side of drainage, listed in upstream to downstream order).

- Winks Canyon is ephemeral and originates in Section 34, T16S R6E. The hydraulic length of this drainage is approximately 4,900 feet with elevations ranging from about 8,610 to 9,600 feet. The drainage area is 287 acres. Six springs (16-34-1 to 17-3-6) are reported in this drainage.
- Dairy Canyon is ephemeral and originates in Section 3, T17S R6E. The hydraulic length of this drainage is approximately 5,500 feet with elevations ranging from about 8,400 to 9,600 feet. The drainage area is 409 acres. Nine springs (17-3-1 to 17-3-9) are reported in this drainage.
- South Dairy Canyon is ephemeral and originates in Section 3, T17S R6E. The hydraulic length of this drainage is approximately 5,800 feet with elevations ranging from about 8,350 to 9,600 feet. The drainage area is 445 acres. Only one spring (17-3-10) is reported in this drainage.
- Indian Lodge Canyon is an ephemeral drainage originating in Section 10, T17S R6E. The hydraulic length of this drainage is approximately 4,800 feet with elevations ranging from about 8,200 to 9,600 feet. The drainage area is 338 acres. One pond (206011) is located in this drainage, in Section 9, T17S R6E.
- Trail Canyon (a.k.a. USFS 306) is a large ephemeral/intermittent drainage originating in Section 16, T17S R6E. The Trail Canyon drainage has an area of 1,626 acres and a hydraulic length of about 12,500 feet. Elevation of the drainage ranges from 7,830 to 9,250 feet. Several springs occur in this drainage including four in Section 15 (17-15-1 through 4) and two in Section 23 (17-23-1 and 2). Three ponds are located in this drainage including one in T17S R6E, Section 22 (22-2P), one in Section 23 (23-1P), and one in Section 16 (206042).
- The Mine Site drainage is ephemeral and originates in Section 26, T17S R6E. The drainage has an area of 358 acres and a hydraulic length of about 4,600 feet with elevations ranging from 7,350 to 9,250 feet. No springs occur in this drainage. Three ponds (26-1P, 2P and 3P) occur in the upper drainage in Section 26, T17S R6E.
- The South Mine site drainage is ephemeral and originates in Section 25, T17S R6E. This drainage has an area of 582 acres and a hydraulic length of about 7,600 feet. Elevation of the drainage ranges from 7,100 to 9,200 feet. Several springs occur in this drainage including one in Section 16 (17-26-4) and one in Section 25 (17-25-1). One pond (26-4P) occurs in Section 26.

Marinus Canyon, Mill Canyon, Roan's Canyon, and Flag Lake Canyon drainages are located on the east side of Cottonwood Canyon Creek and are ephemeral. These drainages are outside the Cottonwood Lease Tract boundary and are not discussed in detail in this document.

**Ponds.** Energy West has recorded eight ponds on Trail Mountain and the Forest Service has records of six additional ponds. The ponds are for stock watering purposes and all but two are runoff fed. Two of the ponds (17-21-3 and 17-21-4) are spring fed. The previous section describes the pond locations per drainage, Table 3.7-1 summarizes the pond data, and the locations are shown on Figure 3.7-1.

**Surface Water Quality.** The surface water in the study area is generally of good quality, with total dissolved solids (TDS) concentrations generally less than 500 mg/l. The pH of the water ranges from 7.00 to 8.93, averaging about 8.00. Predominant cations and anions are calcium and bicarbonate with minor amounts of magnesium, sodium, and sulfate. The primary trace constituents include iron and manganese. Sediment yields in the upper Cottonwood Creek drainage were estimated at 0.1 acre-feet per square mile (SCS, 1973). A summary of the surface water quality is provided in Table 3.7-2.

Past and current activities other than mining have affected surface water quality. Livestock grazing causes minor impacts due to erosion and sedimentation and water quality, i.e. fecal coliform. Unauthorized off-road vehicle use also causes erosion and sedimentation in drainages.

**Mine Water Discharge.** Significant discharge from the Trail Mountain Mine began in June 1997. Minor amounts of discharge were reported prior to this date (PacifiCorp, 1997b). Water currently discharged from the Trail Mountain Mine is either used for mining operations or discharged under an approved Utah Pollutant Discharge Elimination System (UPDES) permit at facilities in Cottonwood Canyon (mine discharge, UTG-040001-002 and sediment pond, UTG-040001—001). These discharge points are located in Section 25, T17S R6E. Current discharge from the Trail Mountain Mine is about 225 gpm or 0.50 cfs (PacifiCorp, 1998d). Reported discharge rates range from 100 to 400 gpm or 0.22 to 0.89 cfs from June 1997 to April 1998 (PacifiCorp, 1998b). The discharged water quality is fair with TDS concentrations ranging from 920 to 1,030 mg/l averaging 975 mg/l (Secondary Maximum Contaminant Level [SMCL] 500 mg/l, EPA, 1994).

Water quality in Cottonwood Canyon Creek has been affected by the mine discharge. Since June 1997, monitoring station SW-2 (located just below the discharge points) indicates elevated levels of average flow, TDS, pH, sodium, bicarbonate, chloride, and sulfate. Farther downstream at station SW-3, elevated levels of flow, pH, TDS, sodium, and bicarbonate have been recorded. It should be noted that the water quality throughout the period of record is within primary water quality standards and exceeds only a few secondary standards. Table 3.7-2 summarizes the mine discharge, and surface water monitoring stations total, pre-mine discharge and post-mine discharge water quality.

**Water Rights.** Surface water rights were reviewed within the proposed Cottonwood Lease Tract and areas extending one mile outside of this boundary. Surface water rights are held on all major streams and many minor streams in the area reviewed. The majority of the water rights are for the purposes of stock watering, however, there are also some for irrigation and industrial purposes.

Cottonwood Creek. On Cottonwood Creek, the Forest Service, BLM and BOR hold stock and irrigation water rights. The BLM and BOR water rights are downstream of the mine portal. The Forest Service's water rights are at locations upstream of the mine portal and adjacent to it.

Cottonwood Creek Consolidated Irrigation Company (CCCI) holds three large multiple use water rights with points of diversion located on Cottonwood Creek, Straight Canyon Creek, Indian Creek, and Lowry Creek. Most of the diversions on Cottonwood Creek are downstream of the mine portal and downstream of the confluence with Straight Canyon Creek. CCCI's water rights are for irrigation, stock watering, municipal (Orangeville and Castle Dale), and industrial purposes (power generation at the Hunter Power Plant).

Other water rights holders on Cottonwood Creek include the State of Utah School & Institutional Trust Lands Administration, Trail Mountain Coal, Inc., Natomas Trail Mountain Coal Co., and individuals with surnames of Peacock and James. These water rights are for stock watering except Natomas Trail Mountain Coal Company, which is for industrial uses.

Straight Canyon Creek. The Forest Service, BLM, and individuals Peacock/James hold stock watering rights on Straight Canyon Creek. CCCI holds four multiple use rights for irrigation, municipal, and industrial purposes. The point of diversion is Hawks Ditch.

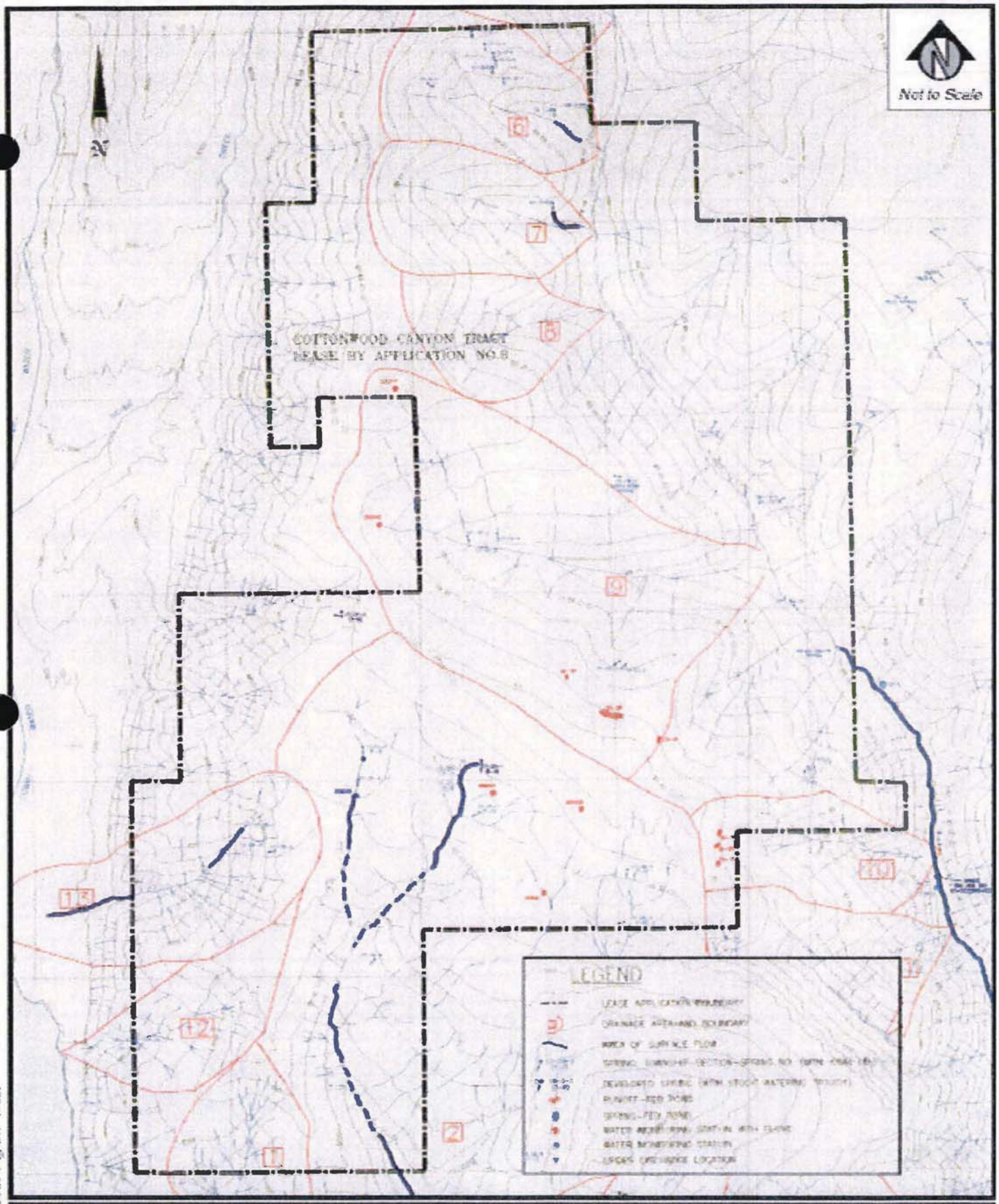
Joes Valley Reservoir. Western Hydro Electric, Inc. and PacifiCorp/Utah Power and Light have unapproved surface water rights applications on file with the Utah Division of Water Resources.

Indian Creek. The Forest Service holds one water right for stock watering. An individual with surname Wilberg holds one water right for domestic/stock watering. CCCI holds six multiple use water rights. CCCI's water rights include irrigation, stock watering, domestic, municipal (Orangeville and Castle Dale),

and industrial uses (power generation at Hunter Power Plant).

Other Water Rights. Other water rights for stock watering are held on Roan's Canyon and Trail Canyon by the Forest Service and on Mill Canyon by the State of Utah School & Institutional Trust Lands Administration. PacifiCorp holds a water right for domestic/mining/other uses at the mine portal.

The Forest Service holds several water rights for stock watering from ponds located in the area of review. The ponds that are within the proposed Cottonwood Lease Tract are located in T17S R6E, Sections 9, 15, 27, 28, and 35 and Section 1, T18S R6E.




**SOURCE**

*Figure prepared from map provided by Mayo and Associates Inc., dated March 8, 1999.*

## Cottonwood Lease Tract EIS
## Surface Water Hydrology Map

| | | |
|---|---|---|
| EWMC0001 | DAVID EVANS AND ASSOCIATES, INC. | FIG. 3.7-1 |
| May 1999 | | Sheet 1 of 1 |

Plot Drawing: EWMC0001-Fig 3.7-1.dgn

**Table 3.7-1**
**Drainage Data Summary**
**Cottonwood Lease Tract EIS**

| Area Number | Name/USFS Code | Classification | Area (Acres) | Profile Length (feet) | Top Elevation (feet) | Bottom Elevation (feet) | Average Slope | Number of Springs (Spring No.) | Ponds (Pond No.) | Potential Impact |
|---|---|---|---|---|---|---|---|---|---|---|
| **Joes Valley Area** | | | | | | | | | | |
| 12 | Sportsman Lodge Canyon | Ephemeral | 383 | 5,000 | 8,600 | 7,000 | 0.32 | 17-32-1,2 | | Minor |
| 13 | Reynolds Canyon | Intermittent | 447 | 7,200 | 9,000 | 7,100 | 0.26 | 17-28-1,2,3 | | Minor |
| **Straight Canyon Area** | | | | | | | | | | |
| 1 | Unnamed/305 | Ephemeral | 285 | 5,400 | 8,500 | 6,800 | 0.31 | 18-4-1 | | Minor |
| 2 | Unnamed/410 | Intermittent | 3,303 | 16,400 | 9,300 | 6,700 | 0.16 | 17-21-3,4/17-22-1,2/17-26-1,2,3/17-27-1,2/17-28-4/17-35-1,2,3,4,5/18-3-1 | 35-1P,2P/1-1P/206040, 206001, 20602, 206006 | Minor |
| 3 | Unnamed/201 | Ephemeral | 448 | 9,100 | 8,900 | 6,550 | 0.26 | 18-2-1 | | Minor |
| 4 | Unnamed/303 | Ephemeral | 900 | 11,400 | 9,100 | 6,530 | 0.22 | | | Minor |
| **Cottonwood Canyon Creek Area** | | | | | | | | | | |
| 5 | Winks Canyon | Ephemeral | 287 | 4,900 | 9,600 | 8,610 | 0.20 | 16-34-1,2,3,4,5,6 | | Minor |
| 6 | Dairy Canyon | Ephemeral | 409 | 5,500 | 9,600 | 8,400 | 0.22 | 17-3-1,2,3,4,5,6,7,8,9 | | Minor |
| 7 | South Dairy Canyon | Ephemeral | 445 | 5,800 | 9,600 | 8,350 | 0.22 | 17-3-10 | | Minor |
| 8 | Indian Lodge | Ephemeral | 338 | 4,800 | 9,600 | 8,200 | 0.29 | | 206011 | Minor |
| 9 | Trail Canyon/306 | Ephemeral/ Intermittent | 1,626 | 12,500 | 9,250 | 7,830 | 0.11 | 17-15-1,2,3,4/17-23-1,2 | 22-2P/23-1P/206042 | Minor |
| 10 | Mine Site | Ephemeral | 358 | 4,600 | 9,250 | 7,350 | 0.41 | | 26-1P,2P,3P | Minor |
| 11 | South Mine Site | Ephemeral | 582 | 7,600 | 9,200 | 7,100 | 0.27 | 17-26-4/17-25-1 | 26-4P | Minor |

Area Number - refers to number on Figure 3.7-1
Spring Designation - Township-Section-Number
Ponds - 206 series ponds are USFS range management designations, P series ponds are Energy West's designations.
Drainage areas, springs, and ponds shown on Figure 3.7-1

**Table 3.7-2**
**Summary of Surface Water Quality**
**Cottonwood Lease Tract EIS**

| Surface Water Station | Flow gpm | pH units | Conduct. umhos | TDS | TSS | Calcium | Potas. | Sodium | Bicarb. | Chloride | Sulfate | Iron Total | Iron Diss. | Magnes. | Mang. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Min | Min | Min | Min | Min | Min | Min | Min | Min | Min | Min | Min | Min | Min |
| | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max | Max |
| | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean | Mean |
| | Samples | Samples | Samples | Samples | Samples | Samples | Samples | Samples | Samples | Samples | Samples | Samples | Samples | Samples | Samples |
| SW-1 | 3.0 | 7.10 | 380 | 226 | 1 | 6.0 | 1.00 | 6.0 | 231 | 0.7 | 20.0 | 0.02 | 0.05 | 2.4 | 0.01 |
| Total | 2,244 | 8.72 | 961 | 690 | 1,298 | 152.3 | 21.00 | 60.0 | 433 | 27.0 | 238.7 | 15.90 | 0.43 | 78.0 | 1.31 |
| | 139 | 7.90 | 674 | 378 | 75 | 66.2 | 3.14 | 21.0 | 339 | 12.9 | 74.4 | 0.95 | 0.13 | 39.2 | 0.09 |
| | 36 | 65 | 31 | 70 | 64 | 69 | 67 | 69 | 70 | 70 | 70 | 65 | 17 | 70 | 55 |
| SW-1 | 3.0 | 7.10 | 380 | 226 | 1 | 6.0 | 1.00 | 6.0 | 231 | 0.7 | 20.0 | 0.02 | 0.05 | 2.4 | 0.01 |
| Pre Mine | 2,244 | 8.72 | 961 | 690 | 1,298 | 152.3 | 21.00 | 60.0 | 433 | 27.0 | 238.7 | 15.90 | 0.43 | 78.0 | 1.31 |
| Dischg. | 140 | 7.88 | 687 | 381 | 77 | 66.7 | 3.19 | 21.5 | 340 | 12.9 | 75.9 | 0.96 | 0.13 | 39.6 | 0.09 |
| | 33 | 62 | 28 | 67 | 61 | 66 | 65 | 66 | 67 | 67 | 67 | 62 | 17 | 67 | 55 |
| SW-1 | 35.0 | 8.14 | 528 | 300 | 6 | 54.0 | 1.00 | 9.0 | 304 | 8.0 | 32.0 | 0.20 | - - | 27.0 | - - |
| Post Mine | 250 | 8.47 | 595 | 300 | 78 | 58.0 | 2.00 | 11.0 | 346 | 22.0 | 50.0 | 1.00 | - - | 33.0 | - - |
| Dischg. | 122 | 8.27 | 552 | 300 | 43 | 55.3 | 1.50 | 10. | 321 | 13.3 | 41.3 | 0.67 | - - | 29.7 | - - |
| | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | | 3 | |
| SW-2 | 2 | 7.00 | 410 | 267 | 1 | 11.1 | 1.00 | 8.0 | 233 | 1.5 | 19.5 | 0.05 | 0.05 | 2.4 | 0.01 |
| Total | 1,700 | 8.93 | 1,709 | 1,170 | 1,004 | 136.9 | 25.60 | 230.0 | 635 | 179.0 | 254.0 | 16.20 | 1.25 | 109.0 | 1.37 |
| | 158 | 8.03 | 840 | 433 | 75 | 65.4 | 4.63 | 36.2 | 343 | 21.0 | 97.2 | 1.14 | 0.18 | 41.8 | 0.10 |
| | 38 | 63 | 29 | 68 | 66 | 68 | 67 | 67 | 68 | 68 | 68 | 66 | 20 | 68 | 57 |
| SW-2 | 2 | 7.00 | 410 | 267 | 1 | 11.1 | 1.00 | 8.0 | 233 | 1.5 | 19.5 | 0.05 | 0.05 | 2.4 | 0.01 |
| Pre Mine | 1,700 | 8.93 | 1,709 | 1,170 | 1,004 | 136.9 | 25.60 | 158.0 | 458 | 179.0 | 254.0 | 16.20 | 1.25 | 109.0 | 1.37 |
| Dischg. | 154 | 8.00 | 804 | 420 | 75 | 67.0 | 4.74 | 28.8 | 333 | 19.6 | 95.9 | 1.17 | 0.18 | 42.6 | 0.10 |
| | 34 | 59 | 25 | 64 | 62 | 64 | 63 | 63 | 64 | 64 | 64 | 62 | 17 | 64 | 56 |
| SW-2 | 80 | 8.42 | 531 | 310 | 13 | 28.0 | 1.00 | 11.0 | 308 | 10.0 | 35.0 | 0.40 | 0.10 | 19.0 | 0.10 |
| Post Mine | 280 | 8.64 | 1,330 | 834 | 148 | 54.0 | 4.00 | 230.0 | 635 | 107.0 | 153.0 | 1.40 | 0.20 | 39.0 | 0.10 |
| Dischg. | 198 | 8.53 | 1,064 | 649 | 65 | 40.3 | 3.00 | 151.5 | 502 | 44.3 | 119.0 | 0.80 | 0.17 | 28.8 | 0.10 |
| | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 1 |
| (1) Drinking Water Stds . | | 6.5-8.5 | | 500 | | | | | | 250 | 250 | 0.3 | | | 0.05 |

**Table 3.7-2**
**Continued**

| Surface Water Station | Flow gpm Min Max Mean Samples | pH units Min Max Mean Samples | Conduct. umhos Min Max Mean Samples | TDS Min Max Mean Samples | TSS Min Max Mean Samples | Calcium Min Max Mean Samples | Potas. Min Max Mean Samples | Sodium Min Max Mean Samples | Bicarb. Min Max Mean Samples | Chloride Min Max Mean Samples | Sulfate Min Max Mean Samples | Iron Total Min Max Mean Samples | Iron Diss. Min Max Mean Samples | Magnes. Min Max Mean Samples | Mang. Min Max Mean Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW-3 | 3 | 7.20 | 506 | 40 | 1 | 14.3 | 1.00 | 3.0 | 253 | 1.7 | 22.0 | 0.04 | 0.05 | 2.4 | 0.01 |
| Total | 1,795 | 8.72 | 1,595 | 1,130 | 5,024 | 159.0 | 30.00 | 267.0 | 633 | 95.0 | 438.0 | 19.00 | 0.43 | 97.0 | 2.48 |
| | 160 | 8.03 | 1,135 | 547 | 153 | 75.3 | 4.33 | 51.4 | 355 | 28.0 | 162.0 | 1.24 | 0.14 | 49.4 | 0.14 |
| | 42 | 67 | 33 | 72 | 65 | 71 | 70 | 71 | 72 | 71 | 72 | 65 | 21 | 72 | 53 |
| SW-3 | 3 | 7.20 | 506 | 40 | 1 | 14.3 | 1.00 | 3.0 | 253 | 1.7 | 22.0 | 0.04 | 0.05 | 2.4 | 0.01 |
| Pre Mine | 1,795 | 8.69 | 1,595 | 1,130 | 5,024 | 159.0 | 30.00 | 108.0 | 452 | 95.0 | 438.0 | 19.00 | 0.43 | 97.0 | 2.48 |
| Dischg. | 149 | 8.00 | 1,131 | 536 | 158 | 77.9 | 4.38 | 43.0 | 345 | 27.6 | 161.9 | 1.27 | 0.14 | 50.6 | 0.14 |
| | 38 | 63 | 29 | 68 | 61 | 67 | 66 | 67 | 68 | 67 | 68 | 61 | 18 | 68 | 52 |
| SW-3 | 175 | 8.46 | 795 | 490 | 11 | 20.0 | 2.00 | 67.0 | 350 | 22.0 | 121.0 | 0.50 | 0.10 | 24.0 | 0.10 |
| Post Mine | 400 | 8.72 | 1,361 | 876 | 114 | 47.0 | 4.00 | 267.0 | 633 | 50.0 | 188.0 | 1.10 | 0.20 | 31.0 | 0.10 |
| Dischg. | 264 | 8.59 | 1,166 | 734 | 63 | 33.0 | 3.50 | 192.3 | 525 | 34.3 | 163.8 | 0.80 | 0.17 | 28.3 | 0.10 |
| | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 1 |
| (2)TM-DIS | 100 | 8.07 | 1,463 | 920 | 6 | 20.0 | 3.00 | 281.0 | 596 | 10.0 | 164.0 | 0.50 | 0.20 | 16.0 | 0.10 |
| | 400 | 8.49 | 1,570 | 1,030 | 46 | 49.0 | 5.00 | 350.0 | 836 | 39.0 | 277.0 | 1.40 | 0.40 | 24.0 | 0.20 |
| | 170 | 8.28 | 1,520 | 975 | 18 | 26.2 | 4.80 | 322.0 | 732 | 31.6 | 204.5 | 0.91 | 0.32 | 18.2 | 0.15 |
| | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 2 |
| CCC-01 | 352 | 7.30 | 500 | 289 | 1 | 41.6 | 0.05 | 12.5 | 237 | 1.5 | 24.0 | 0.08 | - - | 2.0 | 0.01 |
| | 2,800 | 8.50 | 610 | 1,685 | 20,000 | 257.0 | 106.00 | 236.0 | 413 | 597.0 | 384.0 | 20.30 | - - | 61.2 | 7.97 |
| | 1,188 | 7.89 | 555 | 431 | 991 | 84.8 | 9.66 | 35.8 | 325 | 38.3 | 111.5 | 3.04 | - - | 33.2 | 0.58 |
| | 5 | 22 | 2 | 22 | 22 | 22 | 22 | 21 | 22 | 22 | 22 | 22 | - - | 22 | 21 |
| (1) Drinking Water Stds . | | 6.5-8.5 | | 500 | | | | | | 250 | 250 | 0.3 | | | 0.05 |

All values are mg/l unless otherwise noted
(1) U.S. EPA Secondary Maximum Contaminant Level Standards
(2) Trail Mountain Mine Discharge, station # UPDES 002

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## ACRONYMS USED IN SURFACE WATER SECTION 3.7

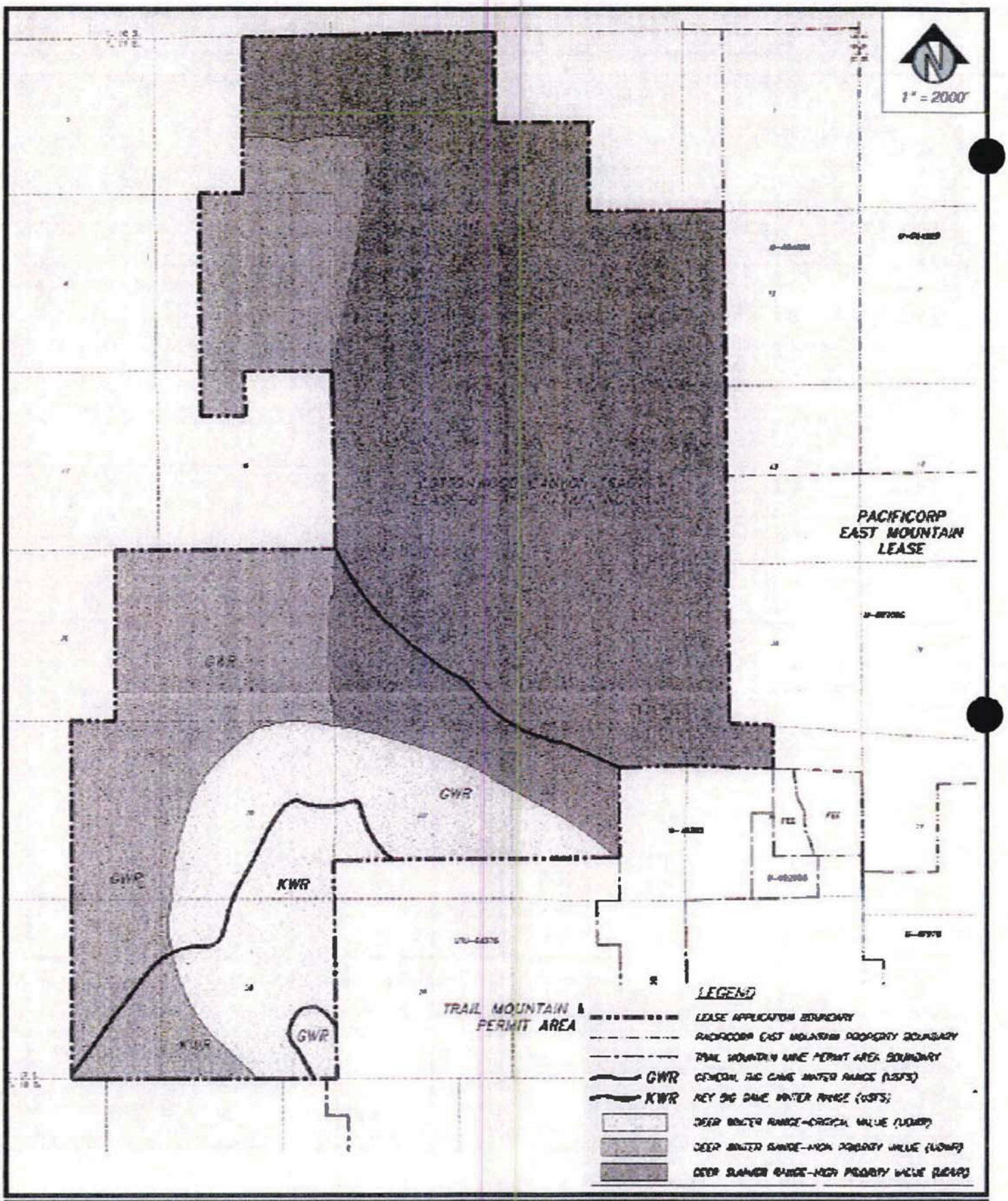
| | |
|---|---|
| BLM | U.S. Bureau of Land Management |
| BOR | U.S. Bureau of Reclamation (BOR). |
| CCCI | Cottonwood Creek Consolidated Irrigation Company |
| cfs | cubic feet per second |
| CWA | Clean Water Act |
| DEA | David Evans and Associates |
| EPA | U.S. Environmental Protection Agency |
| EIS | Environmental Impact Statement |
| gpm | gallons per minute |
| mg/l | milligram per liter |
| NEPA | National Environmental Policy Act |
| NPDES | National Pollutant Discharge Elimination System |
| SMCL | Secondary Maximum Contaminant Level |
| SMCRA | Surface Mining Control and Reclamation Act |
| TDS | Total dissolved solids |
| UDNR | Utah Division of Natural Resources |
| UPDES | Utah Pollutant Discharge Elimination System |
| USFS | U.S. Forest Service |
| USGS | U.S. Geological Survey |

# 3.8 WILDLIFE

## 3.8.1 Executive Summary

The primary issues and areas of concern regarding wildlife resources and underground mining in the Cottonwood Lease Area relate to the following.

- Extent and characteristics of habitats potentially disturbed by the proposed operation.
- Potential impacts of subsidence to unique habitats such as wetlands, riparian areas, rock outcrop and wildlife species dependent on these habitats.
- Potential impacts of subsidence to wildlife water sources (e.g., seeps and springs).
- Potential for impacts to game species; raptors; state or federally listed threatened, endangered, proposed, and candidate species or BLM and forest sensitive species; Forest Plan management indicator species; and other ecologically important species and associated habitats.

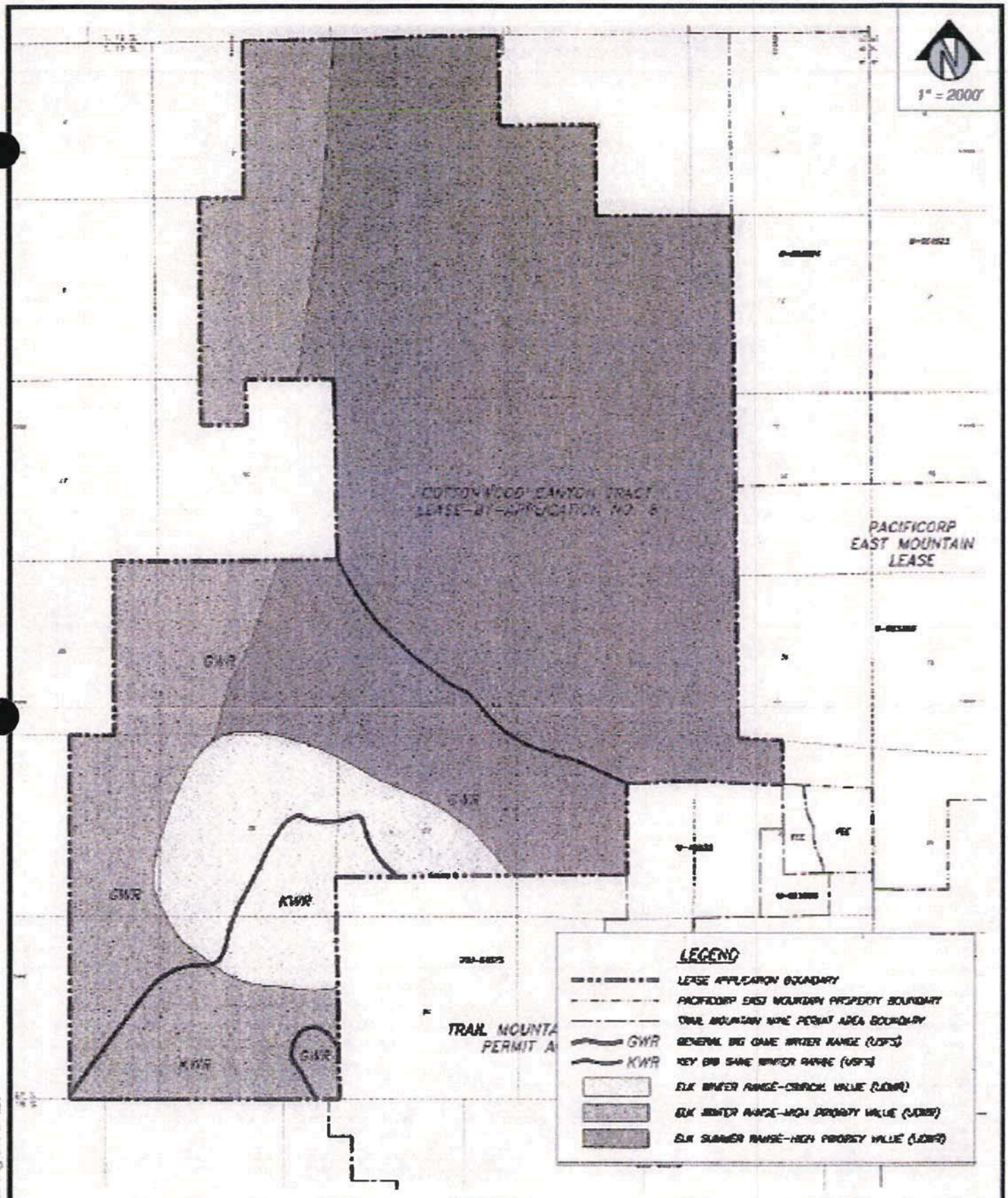



**SOURCE**
Energy West Mining Company, February 27, 1996

# Cottonwood Lease Tract EIS
## Deer Range

| | | |
|---|---|---|
| EWMC0001 | | FIG. 3.8-1 |
| May 1999 | DAVID EVANS AND ASSOCIATES, INC. | Sheet 1 of 1 |

Ref. Drafting\4b-1 av\EWMC0001-Fig 3.8-1.dgn

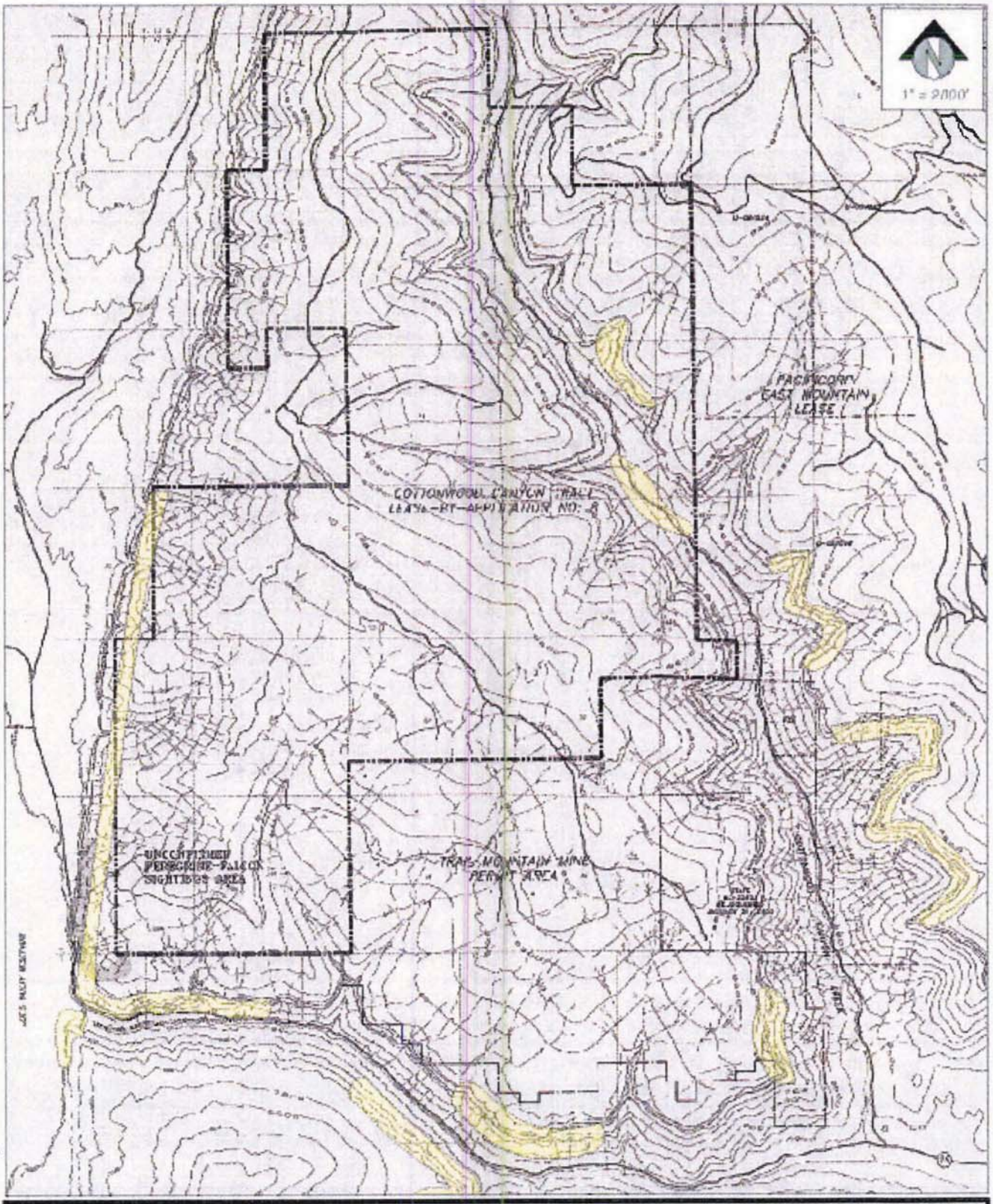



**SOURCE**
Energy West Mining Company, February 27, 1996

## Cottonwood Lease Tract EIS
## Elk Range

| EWMC0001 | | FIG. 3.8-2 |
|---|---|---|
| May 1999 | DAVID EVANS AND ASSOCIATES, INC. | Sheet 1 of 1 |

Hal Drafting/Maps/EWMC0001-Fig 3.8-2.dgn



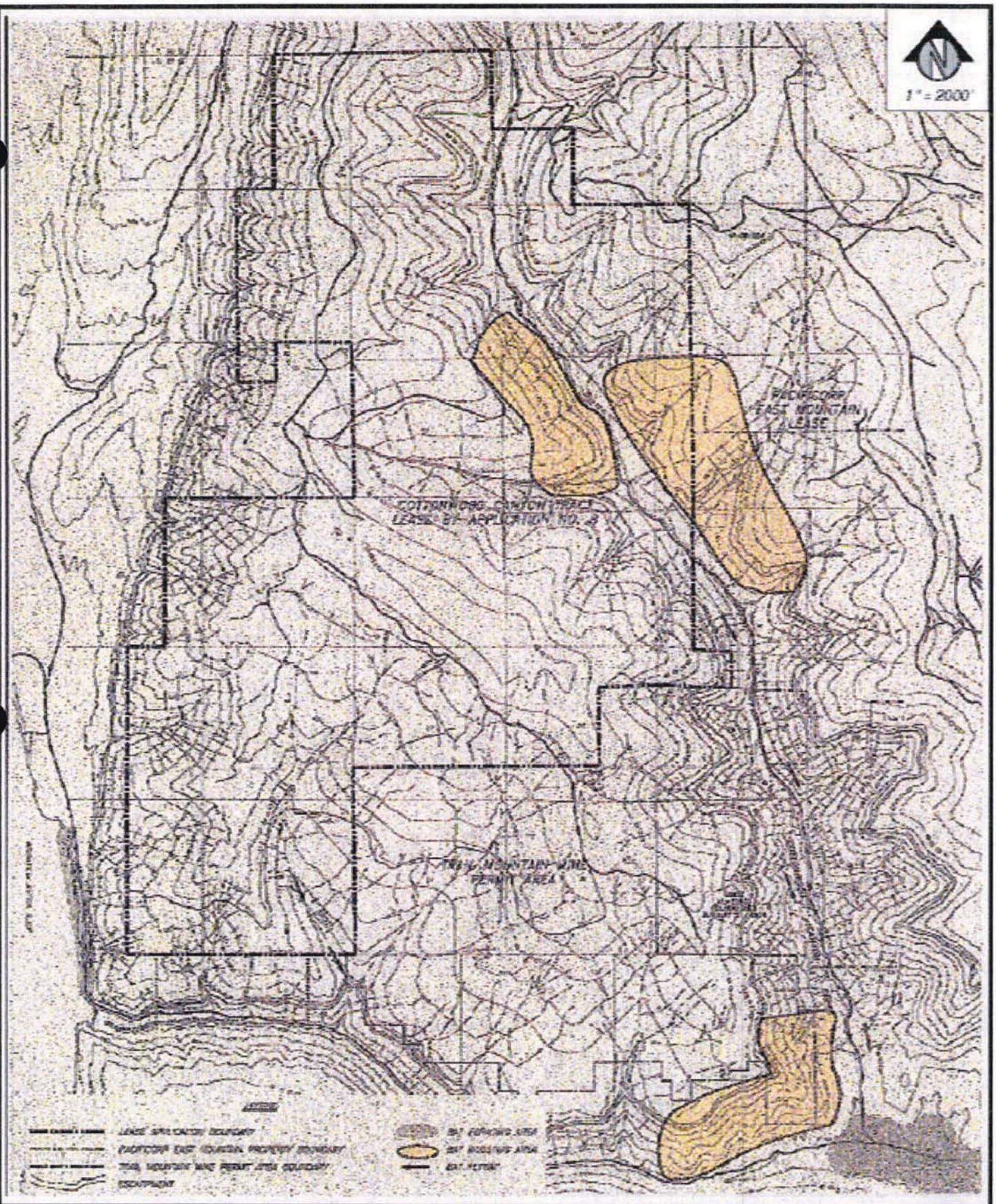

**SOURCE**

Energy West Mining Company, September 18, 1997

**Cottonwood Lease Tract EIS**
**Raptor Nesting Areas**

| | | |
|---|---|---|
| EWMC0001 | DAVID EVANS AND ASSOCIATES, INC. | FIG. 3.6-3 |
| May 1999 | | Sheet 1 of 1 |

Ref. Drawings:M:\Jobs\EWMC0001\Fig. 3.6-3.dgn




**SOURCE**

*Energy West Mining Company, February 27, 1996.*

## Cottonwood Lease Tract EIS
## Bat Habitat

| | | |
|---|---|---|
| EWMC0001 | DAVID EVANS AND ASSOCIATES, INC | FIG. 3.6-4 |
| May 1999 | | Sheet 1 of 1 |

Ref. Drafting: EWMC0001-Fig 3.6-4 .dgn

## 3.8.2 Introduction

This section addresses wildlife species of concern within the wildlife study area. The study area covers approximately 45 square miles on the southern portion of Trail Mountain, which contains the entire Cotton-wood Creek watershed. This area includes the entire lease area and surrounding habitats, and its boundaries are generally defined by State Highway 29 to the south, Miller Flat Road to the west, a line 1 mile east of the R6E and R7E boundary to the east, and a line 1 mile north of the T16S and T17S boundary to the north. The extent and boundaries of the study area addressed by this document were delineated in consultation with Forest Service personnel. For most wildlife, direct, indirect, and reasonably foreseeable cumulative effects would be confined within the wildlife study area boundaries. For mule deer, elk, and threatened and endangered species (bald eagle and peregrine falcon), larger regional population areas were evaluated to assess potential project related impacts.

Wildlife species and issues of concern addressed by this analysis were determined through consultation with state and federal agency personnel, a review of agency and public comments received during the EIS scoping process, and evaluation of potential species presence provided in PacifiCorp (1997) and other pertinent information sources. Criteria for evaluating wildlife issues are as follows.

- Extent and characteristics of habitats potentially disturbed by the proposed operation.
- Potential impacts of subsidence to unique habitats such as wetlands, riparian areas, rock outcrop and wildlife species dependent on these habitats.
- Potential impacts of subsidence to wildlife water sources (e.g., seeps and springs).
- Potential for impacts to game species; raptors; state or federally listed threatened, endangered, proposed, and candidate species or BLM and Forest- sensitive species; Forest Plan management indicator species, and other ecologically important species and associated habitats.

Information regarding wildlife species and current habitat conditions within the study area was obtained from a review of existing published sources, Forest Service file information, Utah Division of Wildlife Resources (UDWR) files, and PacifiCorp (1997). Discussions of wildlife populations within the study area are provided under the following categories: Big Game; Raptors, Forest Plan management indicator species, and Species of Special Concern (threatened, endangered, and sensitive species). A complete listing of wildlife species potentially residing within the study area as well as information on relative abundance and habitat associations is provided in PacifiCorp (1997).

## 3.8.3 Affected Environment

### *Big Game*

Elk and mule deer are the two big game species of concern. Both are economically important big game animals and are common inhabitants of the Wasatch Plateau. Elk tend to occupy the higher elevation aspen and mixed conifer habitats from spring through early fall and move to lower elevation mixed shrub, pinyon-juniper, and sagebrush habitats for winter range, although some use of higher elevation mixed shrub habitats occurs where exposure and wind limit snow accumulations. Elk generally occupy winter range from December 1 through April 15. Elk parturition (calving) typically takes place between May 15 and July 5 and occurs in areas of suitable aspen habitat. Protection of winter range and calving habitat is considered a key factor in the maintenance of elk populations in the study area. Forage available within calving habitat is especially important since elk nutritional demands for successful calving, cow recovery, and early calf growth are higher than those associated with any other season.

Mule deer use most habitat types within the study area during spring through fall but are most abundant in shrublands in rough, broken terrain where abundant food and cover are provided. Mule deer populations within the study area also exhibit seasonal movement with most shifts in distribution occurring as a result of elevational migration in response to snow cover. Lower elevation pinyon-juniper and sagebrush habitats represent suitable winter range, and most portions of mule deer winter range are located at the

periphery of National Forest lands and on adjacent private lands. Protection of winter range, especially on National Forest lands, is also considered a key factor for sustaining mule deer populations in the study area.

The majority of the lease area (higher elevation areas in central and northeast portions) represents High Priority Value (UDWR) summer range for deer and elk, although the lower elevations of the eastern and southeast portions of the lease area provide High Priority Value and Critical Value (UDWR) winter range for both species (Figure 3.8-1, Deer Range and Figure 3.8-2, Elk Range). The UDWR defines Critical habitat as sensitive use areas that are limited in availability or provide unique qualities for high interest wildlife. High Priority habitat is defined as an intensive use area that, due to relatively wide distribution, do not constitute critical values but which are highly important to high interest species.

### *Raptors*

Several species of raptors are known to occur and nest within the region of the study area. Potential breeders include turkey vulture, northern harrier, golden eagle, Cooper's hawk, sharp-shinned hawk, northern goshawk, red-tailed hawk, prairie falcon, peregrine falcon, American kestrel, western screech owl, flammulated owl, great horned owl, northern pygmy owl, long-eared owl, short-eared owl, and northern saw-whet owl. Northern goshawk, flammulated owl, and peregrine falcon are species of special concern and are addressed in the following section.

Nest site preferences of raptors potentially breeding in the area vary considerably. Red-tailed hawks, golden eagles and great horned owls typically nest in relatively large trees with open crowns or on cliff ledges and areas of rock outcrop. Great horned owls do not build their own nests and often occupy old nests of eagles, hawks, ravens, crows, and tree squirrels in larger trees or on cliff faces. Turkey vultures nest on cliff ledges and also in hollows in snags or stumps, or in caves while prairie falcon nests on scrapes on cliff ledges or in rock cavities. All of these species prefer primarily open shrublands and meadow areas for hunting. Suitable nesting habitat for these species is provided primarily by large cottonwood trees along Cottonwood Creek and Straight Canyon or by cliffs and rock escarpments along Cottonwood Creek Canyon, Straight Canyon, and the east side of Joes Valley. Nesting by golden eagle, red-tailed hawk, prairie falcon, and peregrine falcon has been documented in these areas of rock escarpment (UDWR file information and PacifiCorp, 1997). Areas of rock escarpment where nesting activity had been documented are depicted on Figure 3.8-3, Raptor Nesting Areas. Because of the potential sensitivity of raptor nest sites to human disturbance, specific raptor nest locations are not provided in this analysis.

The remaining potential breeding raptors in the study area are associated primarily with forested habitats except for northern harrier and short-eared owl. Northern harriers typically nest on the ground or in low shrubs in pockets of dense shrub and grass cover typically on drainage side-slopes or near wetlands. Short-eared owls are also ground nesters and prefer to nest in moist meadow or wetland habitats. Springs and creeks supporting riparian wetland vegetation represent the only areas of suitable nesting habitat within the study area for this species.

Cooper's hawks nest in aspen or in deciduous trees in riparian situations but are also known to nest in mature conifers (Ehrlich et al., 1988; Terres, 1980). Nests are typically constructed in an upper crotch of a tree near the trunk and below the canopy top. Sharp-shinned hawks, unlike Cooper's, nest in a wide variety of wooded habitats ranging from mountain mahogany stands to conifers. Nest configuration and placement is similar to Cooper's hawk.

The American kestrel is a cavity nester, and abandoned woodpecker holes, magpie nests, and crevices in rock outcrop are used as nest sites. A variety of open and wooded habitats are occupied by the American kestrel, although it avoids densely forested habitats.

Western screech owl, northern saw-whet owl, and northern pygmy owl nest in natural tree cavities or abandoned woodpecker or squirrel holes. Western screech owls are usually found in deciduous riparian habitats, while mature and old-growth mixed deciduous and coniferous forests are considered the best habitats for breeding for northern saw-whet and northern pygmy owls since the most suitable cavities for nesting are excavated by woodpeckers in large, diseased or dead trees (Reynolds et al., 1989). Northern saw-whet owls and northern pygmy owls occur over a relatively wide elevational range and have been found in low-elevation deciduous woodlands to high-elevation conifer forests (Reynolds et al., 1989). Northern saw-whet owls seem to prefer marshy or riparian areas within coniferous forests (Terres, 1980). Nests of northern pygmy owls are frequently next to meadow or marshy openings within deciduous woodlands and coniferous forests (Reynolds et al., 1989).

Long-eared owl, like great horned owl, do not build their own nest and usually occupy abandoned magpie, hawk, crow, or squirrel nests in tall shrubs or trees (Ehrlich et al., 1988). They inhabit coniferous and mixed coniferous/deciduous woodlands. Nest sites are often at forest edges near water or moist meadow habitats (Terres, 1980).

### *Forest Plan Management Indicator Species*

The Forest Service identified this species group as a required analysis issue after the initial scope-of-work. Baseline information regarding these species has been provided by the Forest Service, however, no analysis can be completed for these species without additional data collection. In order to address these species, a listing of management indicator species for the Manti-La Sal National Forest needs to be evaluated with respect to their habitat requirements and the potential for proposed coal lease activities to affect these species.

### *Species of Special Concern*

Species of Special Concern potentially inhabiting the study area include bald eagle, American peregrine falcon, northern goshawk, flammulated owl, three-toed woodpecker, Townsend's big-eared bat, and spotted bat. The bald eagle is listed by the U.S. Fish and Wildlife Service as threatened, and the peregrine falcon is listed as endangered The remaining species are listed as sensitive by the Forest Service in Region 4.

**Bald Eagle.** During the breeding season bald eagles are closely associated with water, along coasts, lake shores, or river banks. During the winter bald eagles tend to concentrate wherever food is available. This usually means they are near open water where fish and waterfowl can be caught. They also winter on more upland areas feeding on small mammals and deer carrion. At winter areas, bald eagles commonly roost in large groups. These communal roosts are located in forested stands that provide protection from harsh weather (Stalmaster, 1987).

Bald eagles can often be found near lakes and reservoirs as well as upland areas on the Manti District during the late fall and early winter. However, once lakes and reservoirs freeze over, most eagles will leave the area except those feeding in upland habitats may stay late into the winter. A pair of nesting bald eagles has been located approximately 7 miles east of the Forest Service boundary near the town of Castle Dale. In 1994, a review of the nesting adults and fledglings indicated their foraging habits were within a 5-mile radius from the nest tree (Boschen, 1995). No bald eagles are known to nest on the Forest. Most bald eagle sightings on the District have been at Joes Valley Reservoir and Huntington Canyon. The eagles will use these areas for foraging and resting until heavy snow cover and lack of open water increases. The eagles then continue their winter migration.

Raptor surveys have been conducted on a yearly basis within the Cottonwood Canyon area, but no bald eagle use of the canyon or surrounding forested habitats has been documented. Therefore, no further analysis of this species is necessary.

**American Peregrine Falcon.** American and Arctic peregrine falcons are known to occur throughout the region primarily during spring and fall migration. The project area occurs within the nesting range of the American peregrine falcon. The peregrine's

preferred nest site is a rugged, remote cliff (100 to 300 feet in height) usually overlooking water or marshy areas where prey is abundant (U.S. Fish and Wildlife Service, 1984). Preferred hunting areas include cropland, meadows, river bottoms, marshes, and lakes which attract abundant bird life. Peregrines are known to travel more than 18 miles from the nest site to hunt for food. However, a 10-mile radius around the nest is an average hunting area (U.S. Fish and Wildlife Service, 1984). The peregrine falcon is currently expanding its range within the state of Utah, and migrating or transient peregrines have been seen on the Wasatch Plateau.

Cliffs and rock escarpments along Cottonwood Canyon, Straight Canyon, and the east side of Joes Valley represent suitable nesting habitat for the American peregrine falcon. In 1996, surveys conducted by the Forest Service, Utah Division of Wildlife Resources (UDWR), and PacifiCorp discovered peregrines exhibiting nesting behavior in Cottonwood Canyon (approximately 4 miles east of Joes Valley Reservoir). The pair was observed copulating and defending a territory however, egg laying and incubation did not occur at this site. Additional surveys (1996) conducted by Forest Service personnel found a pair of peregrines occupying a territory on the east rim of South Horn Mountain (approximately 6 miles southeast of Joes Valley Reservoir). This pair was found using the cliff systems directly below the existing electronic site. In 1996 the UDWR discovered an active peregrine nest near the Star Point Mine. The nest contained eggs, but it is not known if the nest produced young. Other known recently active nests are located on cliff areas above the east bank of Joes Valley Reservoir (Moretti, pers. comm., 1998).

**Northern Goshawk.** The northern goshawk inhabits coniferous and mixed forests in much of the northern hemisphere. Blocks of mature and old growth forest habitats (200 acres or greater) with a relatively open understory and small openings are preferred (Hayward et al., 1990). Goshawk nest sites are usually located in mature forests, near water, and on benches of relatively little slope. Nests are often used year after year. Goshawks are very protective of their young in the nest and loudly defend them to intruders. They are very sensitive to human disturbance and have abandoned nests and young due to human activities that take place too close to their nest (Kennedy and Stahlecker, 1991).

The goshawk is a resident of the Ferron-Price Ranger District, but the number of nesting birds vary year to year. Nest sites are associated with aspen and mixed conifer habitats (Forest Service file data). Nest sites and goshawk territories are likely to be present within the study and lease areas.

**Flammulated Owl.** The flammulated owl occurs in western North America from southern Mexico and Guatemala north to southern British Columbia. It winters from central Mexico south to Guatemala and is found in the United States and Canada only from spring through fall. This species is considered a summer resident of uncommon relative abundance, indigenous to the Wasatch Plateau (Dalton et al., 1987).

Flammulated owls prefer mature ponderosa pine and Douglas-fir forests with open canopies. Old growth (>200 years) or mature (>150 years) stands of ponderosa pine and ponderosa/ Douglas-fir forests, often mixed with mature aspen, are preferred as nesting habitat (McCallum, 1994). A preference for stands with an open, park-like spacing of trees may be due to this species' foraging habits (Reynolds et al., 1989). Flammulated owls are obligate cavity nesters, and they nest in natural or woodpecker cavities. Both live and dead ponderosa pine, aspen, and Douglas-fir are used for nesting (Reynolds et al., 1989). Nesting territories are relatively small; a mean size of approximately 14 ha (34.6 acres) was reported by Linkhart (1984) for a population in Colorado.

Recent surveys in southern Utah National Forests have indicated that flammulated owls are more abundant and widely distributed than previously thought (Forest Service file data). Nesting by flammulated owl is likely within suitable habitat in the lease and study areas.

**Three-toed Woodpecker.** Three-toed woodpeckers range across North America. They are found in northern coniferous and mixed forest types up to 9,000 feet in elevation. The UDWR describes the three-toed woodpecker as a yearlong resident species, of uncommon relative abundance that is indigenous to the Wasatch Plateau (Dalton et al., 1987).

Three-toed woodpeckers are associated primarily with mixed coniferous forests. They require snags (standing, dead trees) for feeding, perching, nesting,

and roosting, although they will feed in live trees. Foraging occurs in areas with abundant dead and decayed trees where it eats mostly larvae of wood-boring beetles by peeling the bark of dead conifers to extract wood boring insects (Terres, 1980). They are major predators of the spruce bark beetle (Spahr et al., 1991). Snags at least 12 inches dbh (diameter at breast height) and 15 feet in height are required for its excavated nest cavities (Towry, 1987). Fire- or insect-killed trees are major food sources. Forest fires and areas of insect outbreaks may lead to local increases in woodpecker numbers after 3 to 5 years (Bull et al., 1986; Scott et al., 1980).

Forest Service surveys for three-toed woodpeckers took place in suitable habitat on the Ferron-Price, Sanpete, and Moab-Monticello Ranger Districts in June and July of 1992. Further surveys during the 1993, 1994, 1995, and 1996 field seasons on the Ferron-Price Ranger District resulted in additional three-toed woodpecker findings. This species was found on all districts surveyed (Forest Service file data), and their presence is likely within the lease and study areas.

**Townsend's Big-eared Bat.** Townsend's big-eared bat uses a variety of scrub and forested habitats throughout western North America. They are normally found in woodlands below 9,600 feet in elevation and apparently do not prefer dense coniferous forests (Barbour and Davis, 1969). This bat is usually found in small groups (10 to 100) in mine shafts, caves, and man-made structures, often in view of light. It occurs throughout the western United States, but its distribution seems to be determined by suitable roost and hibernation sites. Caves and mines are most often used as day roosts or hibernacula, but crevices in cliffs and abandoned buildings are also occupied, especially as night roosts (Fitzgerald et al., 1994). Maternity roosts are almost always caves although buildings and bridges are known to be used (Kunz and Marten, 1982). This bat is very sensitive to changes in temperature, and populations may be limited primarily by high winter mortality due to the absence of roosts with stable temperatures (Colorado Division of Wildlife, 1984). The Townsend's Big-eared Bat is very sensitive to human disturbance. It will readily abandon roosts when disturbed. Activities that will or may disturb caves or mines should be evaluated to determine potential impacts to this species (Kunz and Martin, 1982; Utah Division of Wildlife Resources, 1980).

Bat surveys conducted in 1992, found Townsend's big-eared bats using inactive coal mines as hibernacula on the Ferron Ranger District. They were also found roosting in buildings on the Ferron-Price Ranger District in the town of Ferron but were not located in the lease area (Toone, 1992). Bat surveys conducted in the summer of 1997 also did not located any Townsend's big-eared bats within the proposed Cottonwood Lease Area (Sherwin et al., 1997). This study speculated that the presence of Townsend's big-eared bat may be limited primarily by the lack of suitable roost sites, particularly caves and abandoned mines. Abandoned mines within the proposed Cottonwood Lease Area were recently (1985-1990) reclaimed by the Utah Division of Oil, Gas & Mining (UDOGM). Pre-closure surveys conducted by this agency did not identify Townsend's big-eared bats using these sites prior to closure (Arnodt, pers. comm., as cited in Sherwin et al., 1997).

**Spotted Bat.** This bat has been found at scattered locations (primarily in arid country) in the western United States (Barbour and Davis, 1969). Habitat occupied by this bat ranges from low desert to montane coniferous forests normally below 8,000 feet in elevation (Watkins, 1977). Spotted bats occur in scattered areas throughout Utah. They have been found in a variety of habitat types including open ponderosa pine, desert scrub, pinyon-juniper, and open pasture and hay fields. They roost alone in rock crevices high up on steep cliff faces. Cracks and crevices in limestone or sandstone cliffs provide important roosting sites (Leonard and Fenton, 1983; Easterla, 1973), especially where rocky cliffs occur in proximity to riparian areas (Findley et al., 1975).

Summer of 1997 bat surveys detected spotted bats throughout the southern and western (lower elevation) portions of the proposed lease area (Sherwin et al., 1997). The highest concentration of calls were recorded in Cottonwood Canyon and Straight Canyon. These canyons appear to represent "classic" spotted bat habitat with an abundance of fractured sandstone cliffs and large areas of suitable foraging habitat. Specific individual roost sites were not located, but general roosting areas were on cliff faces/rock outcrops in Cottonwood Canyon within the proposed lease area (Sherwin et al., 1997). Additional roosting areas also were identified throughout the Straight Canyon drainage and portions of Cottonwood Canyon outside of the lease area.

Spotted bats were not observed foraging at any areas within Cottonwood Canyon area. It appeared that the bats were using the proposed lease area primarily as roosting sites, and the canyons were used as flyways to reach lower elevation foraging areas. The principal spotted bat foraging areas were determined to be located over the lower elevation riparian habitat near the mouth of Cottonwood Canyon and along the length of Straight Canyon (Figure 3.8-4, Bat Habitat). Spotted bats appeared to concentrate foraging efforts above the upper canopy of riparian vegetation, especially cottonwood trees (*Populus* ssp).

Spotted bats are not restricted to the proposed lease area, but rather are widely distributed in low densities throughout the entire area. These bats were detected in suitable habitat throughout the area, including using the parking lots of the Village Inn motels in Huntington and Castle Dale (Sherwin et al., 1997).

Observations made during the 1997 surveys indicated that spotted bats tolerate at least moderate human disturbance while foraging. Surveys were conducted at several sites near roads with light to moderate vehicular traffic (Crandall Canyon, Huntington Canyon, Straight Canyon), including tandem trucks used for hauling coal from the Genwal mine portal located in Crandall Canyon. Spotted bats were observed foraging at low elevation sites off the lease areas, sometimes within 30 meters of the right of way. The fact that spotted bats were relatively common in active and previously mined areas may imply that past cliff failures have not dramatically affected resident populations (Sherwin et al., 1997).

### *Fish*

Because all on-site streams are either ephemeral or intermittent, fish are not likely to be present in the Cottonwood Lease area. Numerous species of fish are expected to occupy perennial streams located downslope of the site. The types of fish most likely to reside in these waters include trout (*Oncorhynchus* spp.), char (*Salmo* spp.), suckers (*Catostomus* spp.), chubs (*Gila* spp.), scuplin (*Cottus* spp.), and dace (*Rhinichtys* spp.). Because migratory fish barriers exist downstream, no anadromous fish inhabit the streams in Emery County.

The lower section of Cottonwood Creek in Straight Canyon located about three miles from the Cottonwood Lease Area is perennial and provides the nearest fish habitat to the proposed project site. This section of Cottonwood Creek receives flows from Joes Valley Reservoir through Straight Canyon which helps maintain perennial flow. Fish presence is likely to increase

further downstream in the larger streams and rivers to which Cottonwood Creek ultimately flows.

### Species of Special Concern

The bonytail chub (*Gila elegans*), Colorado squawfish (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*), are listed as endangered species. These species were identified as having critical habitat in Emery County by the U.S. Fish and Wildlife Service. They are each inhabitants of large rivers and do not occur near the Cottonwood Lease Area. The nearest known occurrence of these species is at the mouth of the San Rafael River and in the Green River, over 70 miles from the proposed project area.

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# 3.9 VEGETATION AND RANGE

## 3.9.1 Executive Summary

Documentation of vegetation and range resources and the associated potential for impact is based largely on existing data and professional judgment given anticipated impacts of the proposed project.

**Areas of Controversy and Issues to be Resolved.** There are no significant areas of controversy or issues to be resolved with regard to vegetation or range resources.

**Environmental Consequences.** A total of seven vegetation communities and/or associations were identified in the lease area, none of which are particularly important, unique, or inordinately valuable with the exception of riparian areas. Any interruption of surface and subsurface flows could lead to the loss or alteration of some of these areas especially in Cottonwood Canyon. In addition, only one plant, listed as sensitive by the Forest Service (Canyon Sweetvetch), is in the vicinity, but not in the lease area. Potential impacts to range resources resulting from the proposed action could result from loss of watering sources and/or other range improvements including interference with grazing management as well as an increased potential for the spread of noxious weeds. Special Coal Lease Stipulations where applicable should preclude adverse impacts. Impacts to vegetation and range resources would not be significant under any of the action alternatives with the exception of potential impacts to riparian or wetland vegetation under Alternatives 2 and 4.

## 3.9.2 Introduction

Documentation of vegetation and range resources in the following sections is based on existing information both published and unpublished, as well as professional experience of the author and Forest Service personnel. Sources of this information include file data and limited site-specific studies implemented by PacifiCorp (1997), data and information provided by the Forest Service (1998), the Manti-La Sal National Forest Land and Resources Management Plan (Forest Service, 1986), the Trail Mountain C & H Allotment Management Plan (Forest Service, 1995), and memos and personal communication with Mr. Robert Thompson - Range and Vegetation Specialist (1998), Mr. John Healy - Range Specialist (1998), and Mr. Dale Harber - Geologist and Forest Service Project Coordinator (1998) of the Manti-La Sal National Forest. Evaluation of such information in comparison to the proposed action is based largely on criteria with regard to potential for impacts as well as the Manti-La Sal National Forest Land and Resources Management Plan. Pertinent forest-wide goals identified in this plan include:

- "Certain vegetative types are to be managed such that varying successional stages will be present to provide for a high level of vegetative diversity and productivity."
- "Maintain upward or stable trends in vegetation and soil condition."
- "Invest in range improvements where they will provide the greatest benefit."

The area of study for vegetation resources is restricted to the lease area whereas the area of study for range resources would include both the lease area and those portions of the Trail Mountain cattle and horse allotment that are external to the lease area.

### *Evaluation Criteria*

The following circumstances define those potential impacts with respect to this proposed action, which would be considered significant:

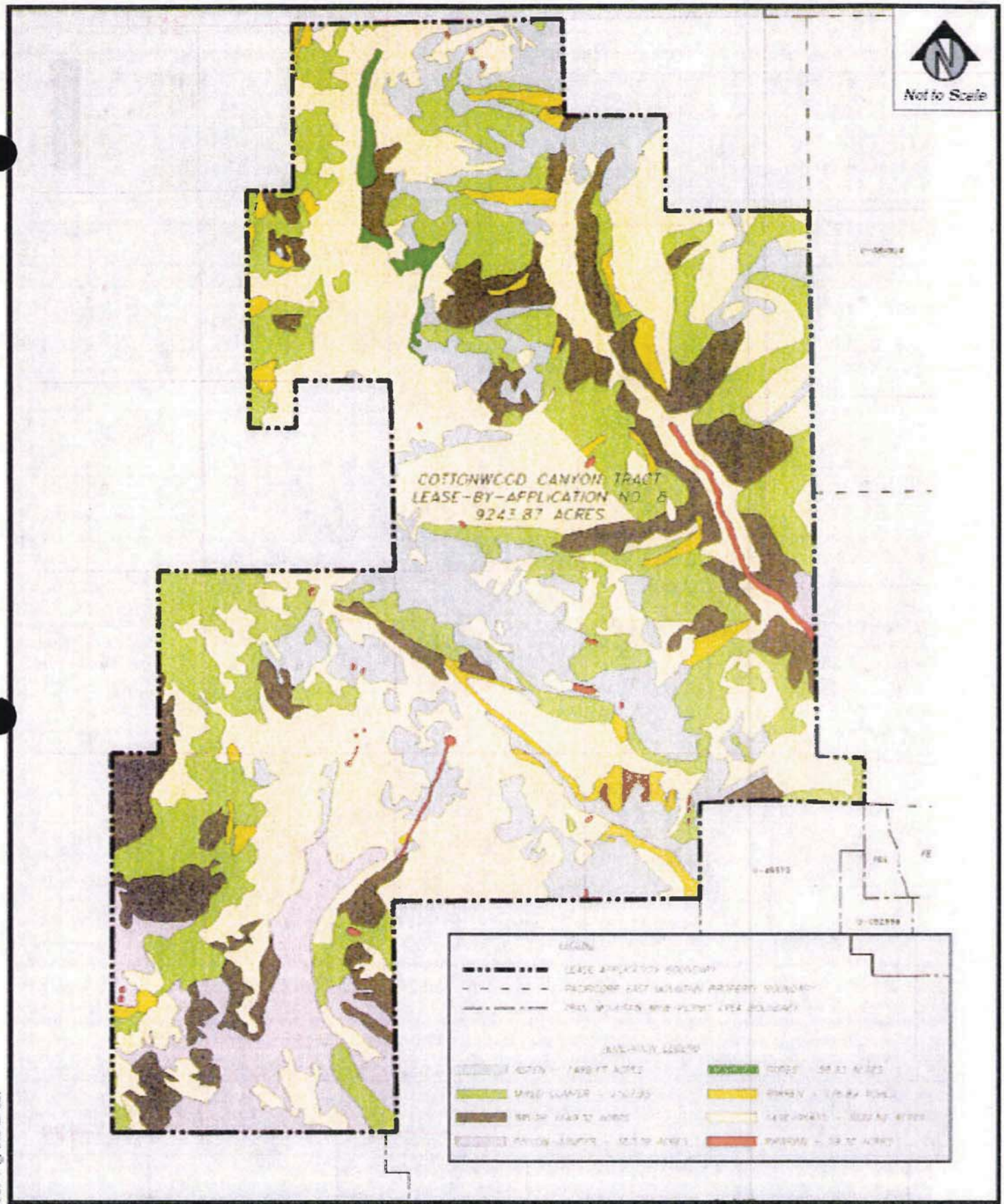
- Any observable or measurable impact to listed Threatened and Endangered species, taxa proposed for listing, candidate species, or impacts to Forest Service sensitive plants which causes said plants to be listed as Threatened or Endangered.
- Adverse impacts to, or interference with, existing rangeland resources and/or appurtenances which lead to severe economic hardship of grazing permittees.
- Direct adverse interference with riparian resources (including wetland habitats) which would then lead (indirectly) to significant adverse effects to either floral or faunal Threatened or Endangered species, or rangeland resources as defined in items one and two above.

## 3.9.3 Affected Environment

### *Vegetation Communities*

Seven segregate upland vegetation communities/ associations were identified in the proposed lease area by PacifiCorp (1997) including: 1) Aspen Woodland, 2) Mixed Conifer Woodland, 3) Mountain Brush, 4) Pinyon-Juniper Wood-land, 5) Forb Meadow, 6) Sagebrush/Grassland, and 7) Riparian Areas (including seep and spring wetlands). One additional land type was identified (Barren), but does not comprise a vegetation community (although it does comprise a habitat type). The acreages and proportion of the lease area associated with these communities is presented on Table 3.9-1 and Figure 3.9-1, while the juxtaposition of these vegetation communities is graphically presented on Figure 3.9-2

A brief description of the seven upland communities and their floral and/or habitat-related attributes are included below; however, it is noteworthy to mention that all of these communities are typical of higher elevation communities of Central Utah.




**SOURCE**

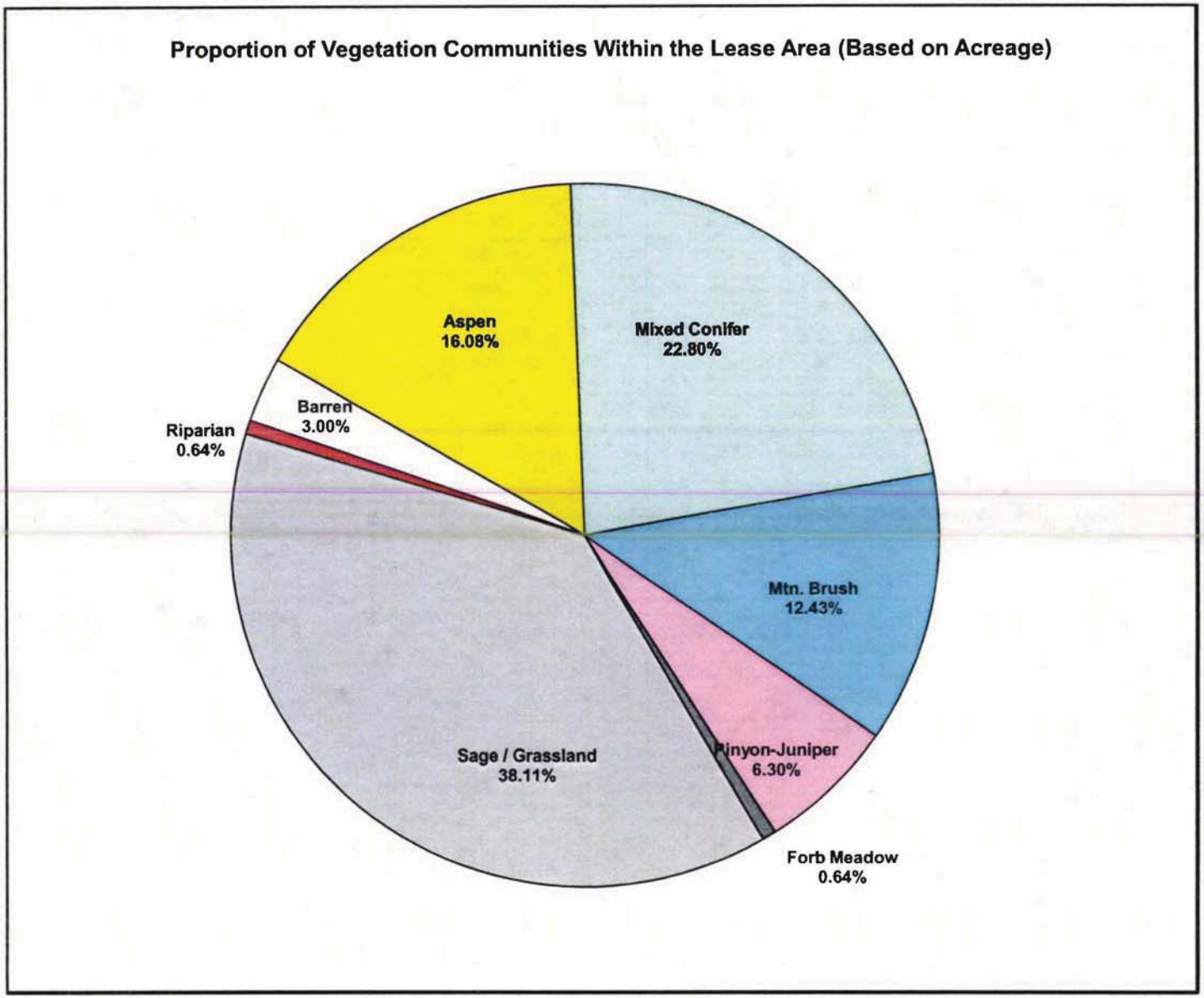
*Energy West Mining Company, May 5, 1998*

**Cottonwood Lease Tract EIS**
**Vegetation**

| | | |
|---|---|---|
| EWMC0001 | DAVID EVANS AND ASSOCIATES, INC. | FIG. 3.9-2 |
| May 1999 | | Sheet 1 of 1 |

Ref. Drawing: EWMC0001-Fig 3.9-2.dgn

Figure 3.9-1

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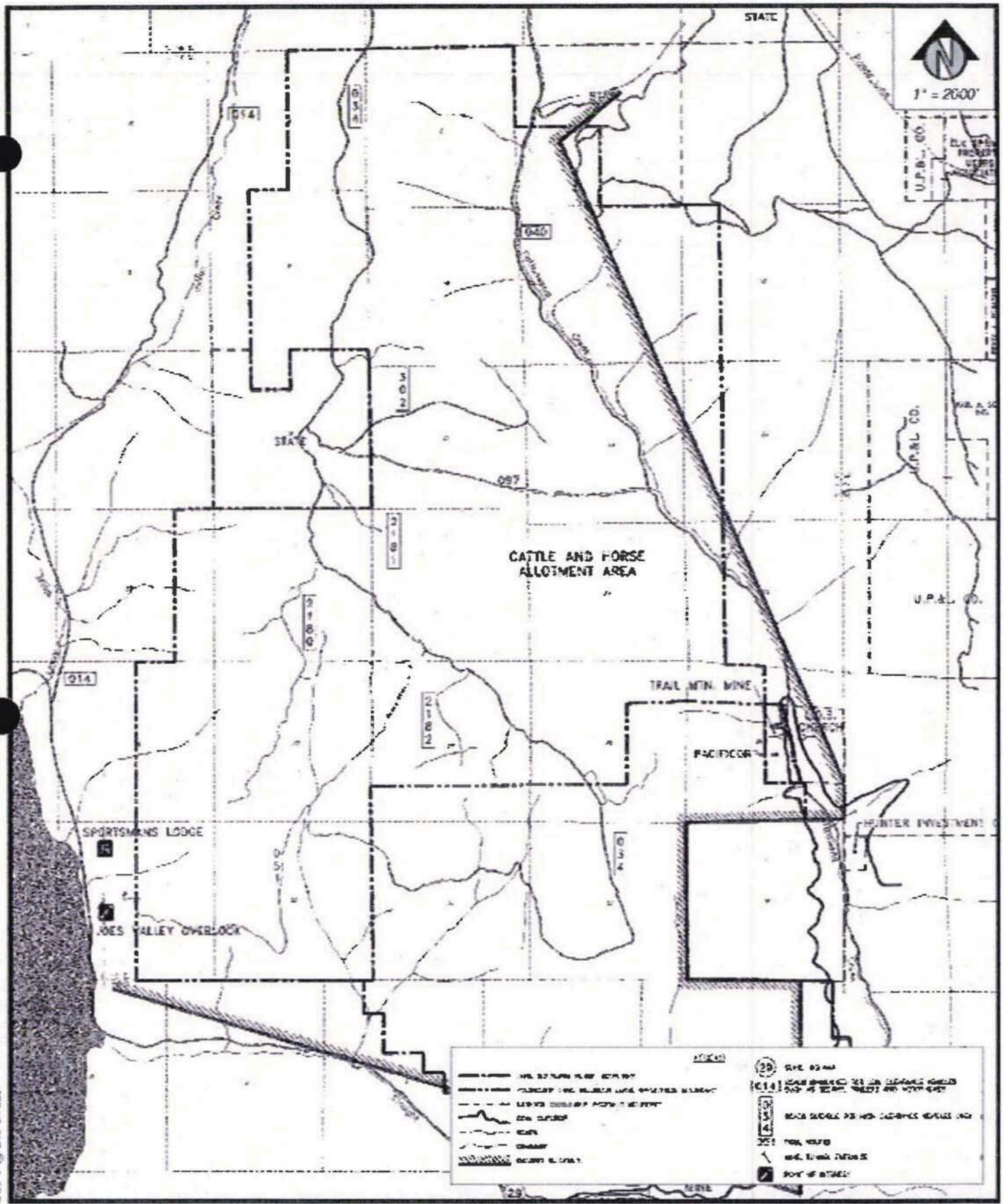



**SOURCE**

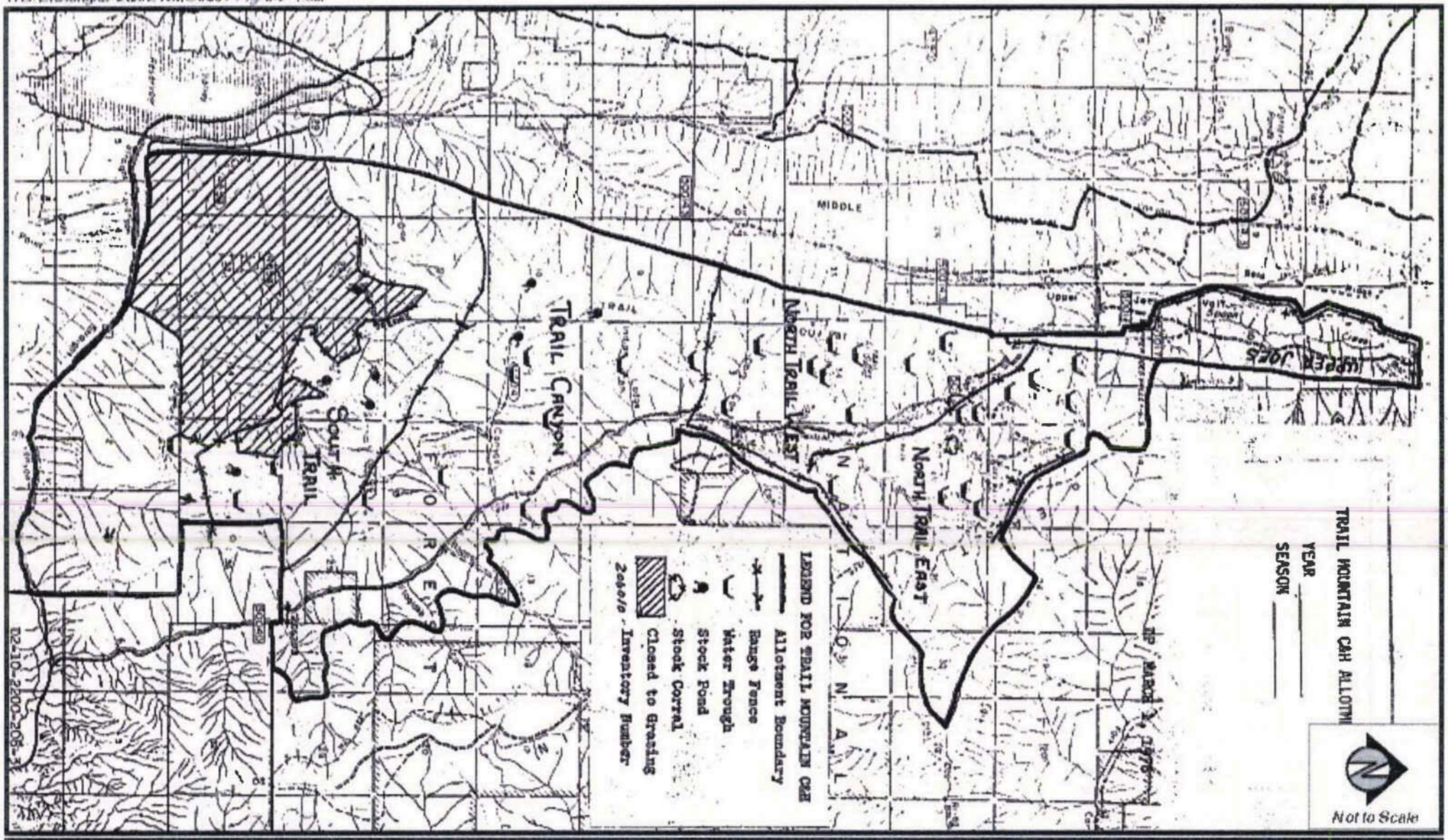
*Energy West Mining Company, October 7, 1997*

## Cottonwood Lease Tract EIS
## Grazing Allotments

| | | |
|---|---|---|
| EWMC0001 | | FIG. 3.9-3 |
| May 1999 | DAVID EVANS AND ASSOCIATES, INC. | Sheet 1 of 1 |

Ref. Drawing#: EWMC0001-Fig 3.9-3.dgn

Ref. Drafting/fb 2a/f: WMC0001-Fig 3.9-4.dgn




**SOURCE**

*Manti - La Sal National Forest, undated*

## Cottonwood Lease Tract EIS
## Trail Mountain Cattle and Horse Allotment

| | | |
|---|---|---|
| EWMC0001 | | FIG. 3.9-4 |
| May 1999 | | Sheet 1 of 1 |

**Table 3.9-1:**
**Lease Area Vegetation Communities - Acreage and Percent of Area**

| | Vegetation Community | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parameter | Aspen | Mixed Conifer | Mtn. Brush | Pinyon-Juniper | Forb Meadow | Sage/ Grassland | Riparian | Barren | Total |
| Acreage in Lease Area | 1,486.2 | 2,107.9 | 1,149.3 | 582.8 | 58.9 | 3,522.5 | 59.3 | 276.9 | 9,243.9 |
| Percent of Lease Area | 16/08% | 22.80 | 12.43 | 6.30 | 0.64 | 38.11 | 0.64 | 3.00 | 100 |

*Aspen Woodland.* This community is the third most extensive in the lease area occupying 1,486 acres or 16.08% of the area, and is found at upper elevations typical of the montane zone (8,000 - 10,000 feet). It is largely located in the northern and central portions of the area along most slopes, aspects, and topographic positions. The Aspen type often intergrades with the Sagebrush/Grassland and Mixed Conifer communities.

Three subtypes of the Aspen community occur within the lease area: 1) aspen/snowberry, 2) aspen/mountain big sagebrush, and 3) aspen/creeping barberry. In all cases, quaking aspen (*Populus tremuloides*) dominates the physiognomic character of the community. Other species present in the understory include: serviceberry (*Amelanchier utahensis*), Oregon grape (*Mahonia repens*), chokecherry (*Prunus virginiana*), Rocky Mountain maple (*Acer grandidentatum*), mountain lover (*Pachistima myrsinites*), snowberry (*Symphoricarpos oreophilus*), bluebunch wheatgrass (*Agropyron spicatum*), mountain brome (*Bromus carinatus*), and Kentucky bluegrass (*Poa pratensis*) (Forest Service, 1998).

*Mixed Conifer Woodland.* This community is the second most extensive in the lease area occupying 2,108 acres or 22.80% of the area, and is found at the uppermost elevations of 8,000 to 10,000 feet (montane zone). It is located throughout the lease area along most slopes and topographic positions, and generally northerly aspects. The Mixed Conifer type often inter-grades with the Sagebrush/ Grassland and Aspen communities.

Five subtypes of the Mixed Conifer community occur within the lease area: 1) Douglas fir, 2) white fir, 3) Englemann spruce, 4) subalpine fir, and 5) ponderosa pine. Douglas fir (*Pseudotsuga menziesii*) usually dominates with white fir (*Abies concolor*) and blue spruce (*Picea pungens*) and is limited to more mesic sites and along watercourses. Englemann spruce (*Picea englemannii*) may codominate with Douglas fir. Subalpine fir (*Abies lasiocarpa*) can be found at higher elevations while ponderosa pine (*Pinus ponderosa*) is usually found lower in the montane zone. Given the often dense overstories, the understory is usually more sparse and generally consists of the same species indicated above for the Aspen community. (Forest Service, 1998).

*Mountain Brush.* This community is the fourth most extensive in the lease area occupying 1,149 acres or 12.43% of the area, and is found at mid-elevations. It is located along valley walls primarily in the northeast and southwest portions of the lease area. The Mountain Brush type often intergrades with the Mixed Conifer community.

Four subtypes of the Mountain Brush community occur within the lease area: 1) serviceberry, 2) oakbrush, 3) Mountain mahogany, and 4) high mountain brush. This community is variably dominated by these subtypes depending on elevation and aspect. The drier south- and west-facing slopes typically support dense stands of Gambel oak (*Quercus gambellii*), the moderate sites support Mountain mahogany (*Cercocarpus montanus* or *Cercocarpus ledifolius*), while the more mesic sites support serviceberry, bitterbrush (*Purshia tridentata*), and snowberry. Understory grasses typically consist of bluebunch wheatgrass, Salina wildrye (*Elymus salinus*), and prairie junegrass (*Koeleria cristata*) (Forest Service, 1998).

*Pinyon-Juniper Woodland.* This community is the fifth most extensive in the lease area occupying 583 acres or 6.3% of the area, and is found at lower to mid-elevations. It is largely located in the southern portion of the area along most slopes, aspects, and topographic positions. The Pinyon-Juniper (PJ) type often intergrades with the Sagebrush/Grassland and Mountain Brush communities.

Three subtypes of the Pinyon-Juniper community occur within the lease area: 1) PJ with mixed mountain brush, 2) PJ with mountain mahogany,

and 3) Rocky Mountain juniper/mountain brush. This community is variably dominated by these subtypes depending on moisture and soil rockiness (the community is generally found on skeletal/ rocky soils). The first two subtypes are dominated by pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) with a significant contribution from Rocky Mountain juniper (*Juniperus scopulorum*). The third subtype is dominated by Rocky Mountain juniper. The typically sparse understory (poor to fair range condition) includes species such as mountain big sagebrush (*Artemisia tridentata* var. *vaseyana*), mountain mahogany, snow-berry, slender wheatgrass (*Agropyron trachycaulum*), Salina wildrye, prairie junegrass, and Indian ricegrass (*Oryzopsis hymenoides*) (Forest Service, 1998).

Forb Meadow. This community is one of the two least extensive in the lease area occupying only 59 acres or 0.64% of the area, and is found at two small locations in the northern portion of the lease area (Figure 3.9-2). The Forb meadow primarily intergrades with the Sagebrush/Grassland and Mountain Brush communities. This community is dominated by a single species, one flowered helianthella (*Helianthella uniflora*).

Sagebrush/Grassland. This community is the most extensive in the lease area occupying 3,523 acres or 38.11% of the area, and is found at all elevations. It is located in all portions of the lease area on all slopes, aspects, and topographic positions. The Sagebrush/ Grassland type intergrades with all of the other communities.

Four subtypes of the Sagebrush/Grassland community occur within the lease area: 1) Mountain big sagebrush, 2) black sagebrush, 3) Salina wildrye, and 4) seeded grasslands. This community is variably dominated by these subtypes depending on moisture, soil depth and texture, and past land management. The first subtype is likely dominant among the four and found throughout the lease area. The second subtype, dominated by black sagebrush (*Artemisia nova*) is typically found on higher elevation ridges and similar topographic positions. The Salina wildrye subtype is found on areas which have historically been subjected to occasional wildfires and are in good or better range condition, while the seeded subtype is entirely dependent upon management actions by the Forest Service. An estimated 1,200 to 1,500 acres of the sagebrush community has been reseeded to grassland (PacifiCorp, 1997). In the moist bottoms, Basin big sagebrush (*Artemisia tridentata* var. *tridentata*) may dominate, but typically mountain big sagebrush dominates elsewhere (excepting for the black sagebrush subtype). Salina wildrye may codominate in many areas and western wheatgrass (*Agropyron smithii*) is quite common (Forest Service, 1998).

Riparian Areas. This community is one of the two least extensive in the lease area occupying only 59.3 acres or 0.64% of the area, and is found only in association with surface water. It is located along intermittent stream courses and in association with larger springs and seeps where a ready supply of water is available for at least a large proportion of the growing season. As a result of these circumstances, riparian areas are disproportionately valuable as habitat for wildlife or watering sources for livestock. Riparian areas can be found in association with any of the other communities.

Three main subtypes of riparian areas can occur within the lease area: 1) sedge wet meadows, 2) birch and willow streamsides, and 3) mesic graminoid seeps and springs. The first and third of these subtypes can occur along streamsides, but are typically found in association with springs and seeps. Given the increased water availability and cooler temperatures, riparian areas tend to exhibit unique and/or more mesic species typical of higher elevations. These assemblages of graminoids (grasses) and shrubs also tend to form dense stands of vegetation. Unique trees and shrubs include narrowleaf cottonwood (*Populus angustifolia*), redosier dogwood (*Cornus sericea*), skunkbush (*Rhus trilobata*), river birch (*Betula occidentalis*), and various willows (*Salix* spp.). Grasses from the more mesic communities (Mountain Brush, Aspen, and Mixed Conifer) may be present in Riparian Areas as well as fescues (*Festuca* spp.), muhlys (*Muhlenbergia* spp.), and a variety of sedges (*Carex* spp.) and rushes (*Juncus* spp.). (U.S. Forest Service, 1998).

Barren. This habitat type occupies only 277 acres or 3.0% of the area, and is typically represented by rock escarpments, rubble slopes, and similar areas in association with the steep canyon walls within

the lease area. Barren areas are not necessarily devoid of vegetation, however, when present, it is generally very sparse and intermittent, only occurring within niches, cracks, crevices, and similar circumstances.

### Special Status Plant Species

According to the U.S. Fish and Wildlife Service, a total of seven plant species in Emery County, Utah are federally listed as threatened (T) or endangered (E) or proposed endangered (PE). The Forest Service also indicates that one plant, listed as sensitive (Sen), could occur in the vicinity of the lease area (Harris, 1998). These taxa are as follows:

| Common Name | Scientific Nomenclature | Status |
|---|---|---|
| Barneby Reed-mustard | *Schoenocrambe barnebyi* | E |
| Jones Cycladenia | *Cycladenia humilis* var. *jonesii* | T |
| Last Chance Townsendia | *Townsendia aprica* | T |

| Common Name | Scientific Nomenclature | Status |
|---|---|---|
| Maguire Daisy | *Erigeron maguirei* | E |
| San Rafael Cactus | *Pediocactus despainii* | E |
| Winkler Cactus | *Pediocactus winkleri* | PE |
| Wright Fishhook Cactus | *Sclerocactus wrightiae* | E |
| Canyon Sweetvetch | *Hedysarum occidentale* var. *canone* | Sen |

Searches of federal databases as well as publications of the Utah Natural Heritage Program (1991) resulted in the determination that no listed threatened or endangered plants are likely to occur within the lease area based on known distributions and habitat preferences of these taxa. Barneby Reed-mustard occurs in southern Emery County on the Chinle Formation amidst mixed shadscale, buckwheat, and ephedra communities. Jones cycladenia occurs in east-central Emery County on gypsiferous saline soils of the Chinle, Cutler, and Summerville Formations in cool desert shrub and juniper communities. Last chance townsendia occurs in southwest Emery County on the clay or clay/silt soils of Arapien and Mancos Shale Formations in salt desert shrub and pinyon-juniper communities. Maguire daisy occurs in southeast/central Emery County on eroded sandstone cliffs of Wingate, Chinle, and Navajo Sandstone Formations amidst mountain brush, mixed conifer, and pinyon-juniper communities. San Rafael cactus occurs in central Emery County on limestone gravels in open pinyon-juniper communities. Winkler cactus occurs along the southern boundary of Emery County in salt desert shrub communities. And Wright fishhook cactus occurs in southwest Emery County on the Mancos Shale Formation in salt desert shrub and pinyon-juniper communities.

The Forest Service sensitive species, canyon sweetvetch, has been identified from northwest Emery County but is not present within the lease area (Harber, pers. comm., 1998). The canyon sweetvetch prefers moist or wet sites such as springs, seeps, and along perennial or intermittent streams between 5,000 and 8,000 feet elevation amidst pinyon-juniper, sagebrush/grassland, and riparian communities. Although not formally protected by legal statute (e.g., the Endangered Species Act), a Forest Service-sensitive species is afforded limited protection in that no management action on the part of the Forest Service can lead to circumstances whereby the taxon would become so imperiled that protection under the Endangered Species Act (e.g., listing) would then become necessary.

### Range Resources

As illustrated on Figure 3.9-3 the lease area lies primarily within a single grazing allotment, Trail Mountain C & H (cattle & horse). A small portion of the northeast quadrant of the proposed lease area underlies the East Mountain Cattle Allotment, but this area is mostly considered to be unsuitable range (Healy, 1998). The Trail Mountain Allotment occupies 21,327 acres (of which 1,188 acres are Utah State lands) in northwestern Emery County. According to the Environmental Assessment for the Allotment (Forest Service, 1995), the allotment exhibits 6,969 acres of land suitable for cattle grazing and is divided into five separate pastures or units to facilitate a rest rotation grazing system that is designed to coordinate livestock grazing with wintering big game species. The five pastures are: 1) Upper Joe's Valley, 2) North Trail East, 3) North Trail West, 4) Trail Canyon, and 5) South Trail; with the proposed coal lease tract underlying portions of the last three pastures (although the majority underlies Trail Canyon and South Trail pastures). These last two pastures are important big game wintering areas and a larger portion of the South Trail unit has been closed to livestock grazing to improve Elk winter range (see Figure 3.9-3).

According to Harber (1998), this area may be reopened to livestock grazing in the reasonably foreseeable future.

The allotment exhibits 3,646 AUMs (Animal Unit Months) of carrying capacity and is permitted for 2,778 AUMs comprised of 906 cow/calf pairs with an allowable grazing season from June 21 to September 20, annually. Of these AUMs, approximately 793 are contributed by the Trail Canyon pasture and 595 are attributable to the South Trail pasture. Based on an overall average without regard to proximity to water or physical barriers, the average existing use in the Trail Mountain Allotment is approximately 0.13 AUMs per acre or 7.7 acres per AUM (Healy, 1998).

The cattle are owned by 19 separate livestock operators from Orangeville or Castle Dale, Utah. Excepting "rested" pastures, cattle enter the allotment by Trail Canyon and then leave via Cottonwood Canyon from the northern units. Past agreements with the mining operator stipulated that coal hauling cease for two days in the spring and again in the fall to eliminate conflicts with trailing cattle. Furthermore, mine facility gates are closed at this time to preclude cattle entry to hazardous areas.

Figure 3.9-4 indicates that several range improvements overlie the proposed coal lease area. These include: four fences, ten water troughs, six stock tanks (ponds), and an unknown number of cattle guards.

## 3.9.4 Environmental Consequences

### *Vegetation Communities*

A total of seven vegetation communities and/or associations were identified in the lease area. None of these communities are particularly important, unique, or inordinately valuable with regard to area resources with the exception of the Riparian Areas. In fact, the non-riparian communities represent some of the most common vegetation types in the Central Utah mountains. Since identified issues reflect this circumstance, the following impact discussion will concentrate upon effects to Riparian Communities/Habitats.

### *Special Status Plant Species*

As indicated previously, no listed threatened or endangered plants occur within or near the lease area, therefore, no adverse effects could occur to these resources. Furthermore, no plants proposed for listing or currently designated as candidates for listing occur on or near the lease area.

## REFERENCES FOR VEGETATION AND RANGE SECTION 3.9

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Harris, Reed E. 1998. USFWS Letter to Janette Kaiser, District Ranger, Manti-La Sal National Forest. re: listed and proposed listed plants and animals in Emery County, Utah. March 25, 1998. 4 pp.

Utah Natural Heritage Program. 1991. Endangered, Threatened, and Sensitive Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service, and the US Fish & Wildlife Service by the Utah Natural Heritage Program. Misc. pagings in loose-leaf format.

U.S. Forest Service. 1998. Facsimile transmission from Dale Harber to Steve Viert, Cedar Creek Associates, Inc.. May 12, 1998. 2 pp.

U.S. Forest Service. 1986. Manti-La Sal National Forest Land and Resource Management Plan. Manti-La Sal National Forest, 330pp.

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Thompson, Robert, Manti-La Sal National Forest. 1998. Personal Communication to Steve Viert, Cedar Creek Associates, Inc., April 1998.

Healy, John, Manti-La Sal National Forest. 1998. Memo to Carter Reed and Dale Harber re: Cottonwood Lease Tract Scoping. March 26, 1998.

Harber, Dale, Manti-La Sal National Forest. 1998. Personal Communication to Steve Viert, Cedar Creek Associates, Inc., May 1998.

Harber, Dale, Manti-La Sal National Forest. Personal Conversation with Diori Kreske, July 1998.

# 3.11 ARCHAEOLOGICAL/CULTURAL RESOURCES

## 3.11.1 Executive Summary

The Cottonwood Canyon Lease Tract represents an area of 9,243.87 acres. PacifiCorp (Energy West Mining Company) has submitted a coal lease application for this lease tract to the Bureau of Land Management. The study area pertinent to cultural resource assessments includes the entire lease application area and is extended beyond to include the base of all escarpments and talus slopes that are immediately below and parallel with the lease area periphery. The extension of the study area beyond the lease area is pertinent to the protection of probable cultural resources that may exist within this landform that is specifically vulnerable to escarpment failure.

**Environmental Consequences.** The project area has had numerous cultural resource surveys and inventories. This information facilitates the determination that the entire upland region of the lease tract has a low potential for significant site disruption related to subsidence of ground surfaces. Additional surface construction or disturbances related to mining operations in the Cottonwood Lease Tract will require cultural resource surveys, thereby providing for the identification and assessment of previously unrecorded archeological sites.

### 3.11.2 Introduction

This discussion of cultural resources reviews the results of past cultural resource surveys and inventories conducted within the proposed Cottonwood Lease Tract. In order to accomplish this task, all relevant materials to the Cottonwood Lease Tract were acquired from the Utah State Files (SHPO-Antiquities). The potential impacts to the cultural resources are detailed based upon information gathered from these studies. The cultural resources discussed here are, in fact, archeological sites. There are no known traditional cultural properties in the area.

The study area pertinent to cultural resource assessments includes the entire lease application area and is extended beyond to include the base of all escarpments and talus slopes that are immediately below and parallel with the lease area periphery. The extension of the study area beyond the lease area is pertinent to the protection of probable cultural resources that may exist within this landform that is specifically vulnerable to escarpment failure.

### 3.11.3 Affected Environment

To date, there have been no specific efforts to compile a synthesis of the prehistory and history of the Trail Mountain/Cottonwood Canyon areas. This lack of a cultural-historical schematic is primarily due to the level of research conducted in the vicinity. The vast majority of the field research in the area has been restricted to cultural resource surveys (Hauck, 1991a). There have been three data recovery excavations of archeological sites in the Trail Mountain locality. All three of these archeological sites (Joes Valley Alcove, Harvest Moon Shelter, and Peephole Shelter) are located immediately adjacent to the lease tract. Therefore, a broad cultural-historical outline does exist for the general area (Hauck, 1991b) and is summarized below.

Currently available information indicates that the Basin and Range Colorado Transition region has been occupied by a variety of cultures beginning perhaps as early as 10,000 B.C. These cultures, as identified by their material remains, demonstrate a cultural developmental process that begins with the earliest identified Paleoindian peoples (10,000 to 7,000 B.C.) and extends through the Archaic (ca. 7,000 B.C. to A.D. 300), and the Formative (ca. A.D. 400 to 1100) Stages, and the Late Prehistoric-Protohistoric periods (ca. A.D. 1200 to 1850) to conclude in the Historic-Modern period which was initiated with the incursion of the Euro-American trappers, explorers, and settlers. Basically, each cultural stage—with the exception of the Late Prehistoric hunting and gathering Shoshonean bands—features a more complex life-way and social order than occurred during the earlier stage of development. For a more comprehensive treatment of the prehistory and history of this general area see *Archaeological Evaluations in the Northern Colorado Plateau Cultural Area* (Hauck, 1991b).

To date, a total of ten cultural resource surveys have been conducted within the proposed lease area. These surveys have encompassed a total of 1,429.87 acres of the 9,243.87-acre project parcel (see Figure 3.11-1). Therefore, 15.47% of the proposed lease tract has been surveyed for cultural resources. In addition, 95.27 acres of the current PacifiCorp lease area have been inventoried for cultural resources (Table 3.11-1).

The studies conducted within the proposed lease tract have resulted in the recording of 17 archeological sites (Table 3.11-2). Eleven of these recorded sites have been assessed as eligible archeological resources applying the National Register of Historic Places criteria for evaluation (36 CFR 60.6 [a-d]). These eligible sites consist of three prehistoric lithic scatters, three prehistoric camp sites, one camp site containing both prehistoric and historic components, one prehistoric hunting blind, one prehistoric occupation with an associated potential rockshelter, an Archaic Stage multi-use site, and a historic period wagon trail.

**Table 3.11-1:**
**Cultural Resource Inventories Conducted within the Current Project Area**

| Title Of Report | Archeological Sites Identified | Environmental Zone(s) | Survey Area |
|---|---|---|---|
| *Archaeological Survey of Trail Mountain Timber Sale*, Manti-La Sal National Forest, CRM Report No. ML-75-47 (Gillio, 1975). | 42EM721 | Plateau | 75 acres |
| *The Central Coal II Project: A Class II Inventory of Selected Portions of Carbon, Emery, and Sevier Counties, Utah.* New World Research, Inc., Louisiana. Manti-La Sal National Forest CRM Report No. ML-80-222 (Weed and Altschul, 1980). | 42EM1286 | Plateau | 160 acres |
| *Cultural Resource Evaluations of Three Proposed Exploratory Drilling Locations in the Trail Mountain Locality of Emery County, Utah.* Report Prepared for Natomas Coal Company (NCC-83-1). Archeological-Environmental Research Corporation, Bountiful (Hauck, 1983). | None | Plateau | 16.45 acres |
| *Cultural Resource Inventory of the Battleground Watershed Improvement Project*, Manti-La Sal National Forest CRM Report No. ML-86-425 (Broadbear, 1986). | None | Plateau | 125 acres |
| *Cultural Resource Evaluations of Nine Exploratory Well Locations and Access Routes in the Trail Mountain Locality of Emery County, Utah.* Report Prepared for the Beaver Creek Coal Company (BCCC-88-2). Archeological-Environmental Research Corporation, Bountiful (Hauck, 1988). | None | Plateau | 3.9 acres |
| *An Archeological Evaluation of Six Proposed Coal Exploratory Locations and Associated Access Routes in the Trail Mountain Locality of Emery County, Utah.* Report Prepared for the Utah Power and Light Company (UPL-90-1). Archeological-Environmental Research Corporation, Bountiful (Hauck, 1990a). | None | Plateau | 33.17 acres |
| *A Cultural Resources Evaluation of Two Proposed Coal Exploratory Locations on Trail Mountain in Emery County, Utah.* Report Prepared for the Utah Power and Light Company (UPL-90-4). Archeological-Environmental Research Corporation, Bountiful (Hauck, 1990b) | None | Plateau | 3.25 acres |
| *Prehistoric Occupations in the Trail Mountain Locality of Emery County, Utah.* Report Prepared for the Utah Power and Light Company (UPL-91-2). Archeological-Environmental Research Corporation, Bountiful (Hauck, 1991a). | 42EM2258 through 42EM2272 | Plateau Canyon Floor Canyon Wall | 1000 acres |
| *Cultural Resource Evaluation of Two Proposed Exploratory Drill Locations in the Cottonwood Creek Locality of Emery County, Utah.* Report Prepared for the Utah Power and Light Company (UPL-92-8). Archeological-Environmental Research Corporation, Bountiful (Hauck, 1992). | None | Canyon Floor | 1.10 acres |
| Cultural Resource Evaluation of Escarpments in the Cottonwood Canyon Locality of Emery County, Utah. Report Prepared for the Energy West Mining Company (EWM-97-2). Archeological-Environmental Research Corporation, Bountiful (Hauck, 1997). | None | Canyon Floor Canyon Wall | 12 acres |
| **TOTAL** | | | 1429.87 acres within proposed lease area. |

**Table 3.11-2:**
**Previously Recorded Archeological Sites Within the Currently Proposed Lease Area**

| Site Number | Recorder | Site Description | National Register Status | Potential For Disturbance From Subsidence | Potential For Disturbance From Escarpment Failure |
|---|---|---|---|---|---|
| 42EM721 | (Gillio 1975) | Prehistoric lithic scatter | Not significant | None | None |
| 42EM1286 | (Weed and Altschul 1980) | Prehistoric lithic scatter | Not significant | None | None |
| 42EM2258 | (Hauck 1991a) | Prehistoric lithic scatter | Not significant | None | None |
| 42EM2259 | (Hauck 1991a) | Prehistoric lithic scatter | Significant | Potential disturbance | None |
| 42EM2260 | (Hauck 1991a) | Archaic stage lithic scatter, campsite, and hunting station | Significant | Potential disturbance | None |
| 42EM2261 | (Hauck 1991a) | Prehistoric camp site | Significant | Potential disturbance | None |
| 42EM2262 | (Hauck 1991a) | Prehistoric and historic camp site | Significant | Potential disturbance | None |
| 42EM2263 | (Hauck 1991a) | Prehistoric camp site | Significant | Potential disturbance | None |
| 42EM2264 | (Hauck 1991a) | Prehistoric lithic scatter | Not significant | None | None |
| 42EM2265 | (Hauck 1991a) | Prehistoric camp site | Significant | Potential disturbance | None |
| 42EM2266 | (Hauck 1991a) | Prehistoric lithic scatter | Significant | Potential disturbance | None |
| 42EM2267 | (Hauck 1991a) | Prehistoric hunting blind | Significant | Potential disturbance | None |
| 42EM2268 | (Hauck 1991a) | Prehistoric lithic scatter | Not significant | None | None |
| 42EM2269 | (Hauck 1991a) | Prehistoric lithic scatter | Significant | None | Potential disturbance |
| 42EM2270 | (Hauck 1991a) | Historic trail / wagon road | Significant | None | Potential disturbance |
| 42EM2271 | (Hauck 1991) | Prehistoric occupation with an associated potential rockshelter | Significant | None | Potential disturbance |
| 42EM2272 | (Hauck 1991) | Prehistoric lithic scatter | Not significant | None | None |

## REFERENCES FOR ARCHAEOLOGICAL/ CULTURAL RESOURCES SECTION 3.11


Barlow, K.R. and D. Metcalfe. 1993. *1990 Archaeological Excavations at Joes Valley Alcove.* Reports of Investigations 93-1, University of Utah Archaeological Center, Salt Lake City.

Broadbear, Bill. 1986. *Cultural Resource Inventory of the Battleground Watershed Improvement Project, Manti-La Sal National Forest*, CRM Report No. ML-86-425. Manuscript on file at the Forest Supervisor's Office, Price, Utah.

DeBloois, E., D.F. Green, and J. Wylie. 1979. *Joes Valley Alcove: An Archaic-Fremont Site in Central Utah.* USDA Forest Service, Intermountain Region, Ogden.

Gillio, David A. 1975. *Archaeological Survey of Trail Mountain Timber Sale, Manti-La Sal National Forest*, CRM Report No. ML-75-47. Manuscript on file at the Forest Supervisor's Office, Price, Utah.

Hauck, F.R.. 1983. *Cultural Resource Evaluations of Three Proposed Exploratory Drilling Locations in the Trail Mountain Locality of Emery County, Utah.* Report Prepared for Natomas Coal Company (NCC-83-1). Archeological-Environmental Research Corporation, Bountiful.

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_____. 1990a *An Archeological Evaluation of Six Proposed Coal Exploratory Locations and Associated Access Routes in the Trail Mountain Locality of Emery County, Utah.* Report Prepared for the Utah Power and Light Company (UPL-90-1). Archeological-Environmental Research Corporation, Bountiful.

_____. 1990b *A Cultural Resources Evaluation of Two Proposed Coal Exploratory Locations on Trail Mountain in Emery County, Utah.* Report Prepared for the Utah Power and Light Company (UPL-90-4). Archeological-Environmental Research Corporation, Bountiful.

_____. 1991a *Prehistoric Occupations in the Trail Mountain Locality of Emery County, Utah.* Report Prepared for the Utah Power and Light

Company (UPL-91-2). Archeological-Environmental Research Corporation, Bountiful.

_____. 1991b *Archaeological Evaluations in the Northern Colorado Plateau Cultural Area: An Investigation of the Seep Ridge-Book Cliffs-Red Wash-Hay Canyon-Whetrock Canyon & Interstate 70-Exit 220 Alternative Highway Routes in Uintah and Grand Counties, Utah.* Report prepared for Uintah and Grand Counties, Utah. Archeological-Environmental Research Corporation, Bountiful.

_____. 1992a *Cultural Resource Evaluation of Two Proposed Exploratory Drill Locations in the Cottonwood Creek Locality of Emery County, Utah.* Report prepared for the Utah Power and Light Company (UPL-92-8). Archeological-Environmental Research Corporation, Bountiful.

_____. 1992b *A Class II Cultural Resource Evaluation of Sample Units in the East Mountain Locality of Emery County, Utah.* Report prepared for Genwal Coal Company (GCC-91-2). Archeological-Environmental Research Corporation, Bountiful.

_____. 1997 *Cultural Resource Evaluation of Escarpments in the Cottonwood Canyon Locality of Emery County, Utah.* Report prepared for the Energy West Mining Company (EWM-97-2). Archeological-Environmental Research Corporation, Bountiful.

Hauck, F.R. and Dennis G. Weder. 1980. *Archeological Sample Survey and Cultural Resource Evaluations of the East Mountain Locality in Emery County, Utah. AERC Paper No. 22.* Report prepared for the Utah Power and Light Company (UPL-80-1). Archeological-Environmental Research Corporation, Bountiful.

Hauck, F.R. and Garth Norman. 1990. *Archeological Studies on East Mountain: A Prehistoric Highland-Lowland Occupation Hypothesis. AERC Paper No. 46.* Report prepared for the Utah Power and Light Company (UPL-90-2). Archeological-Environmental Research Corporation, Bountiful.

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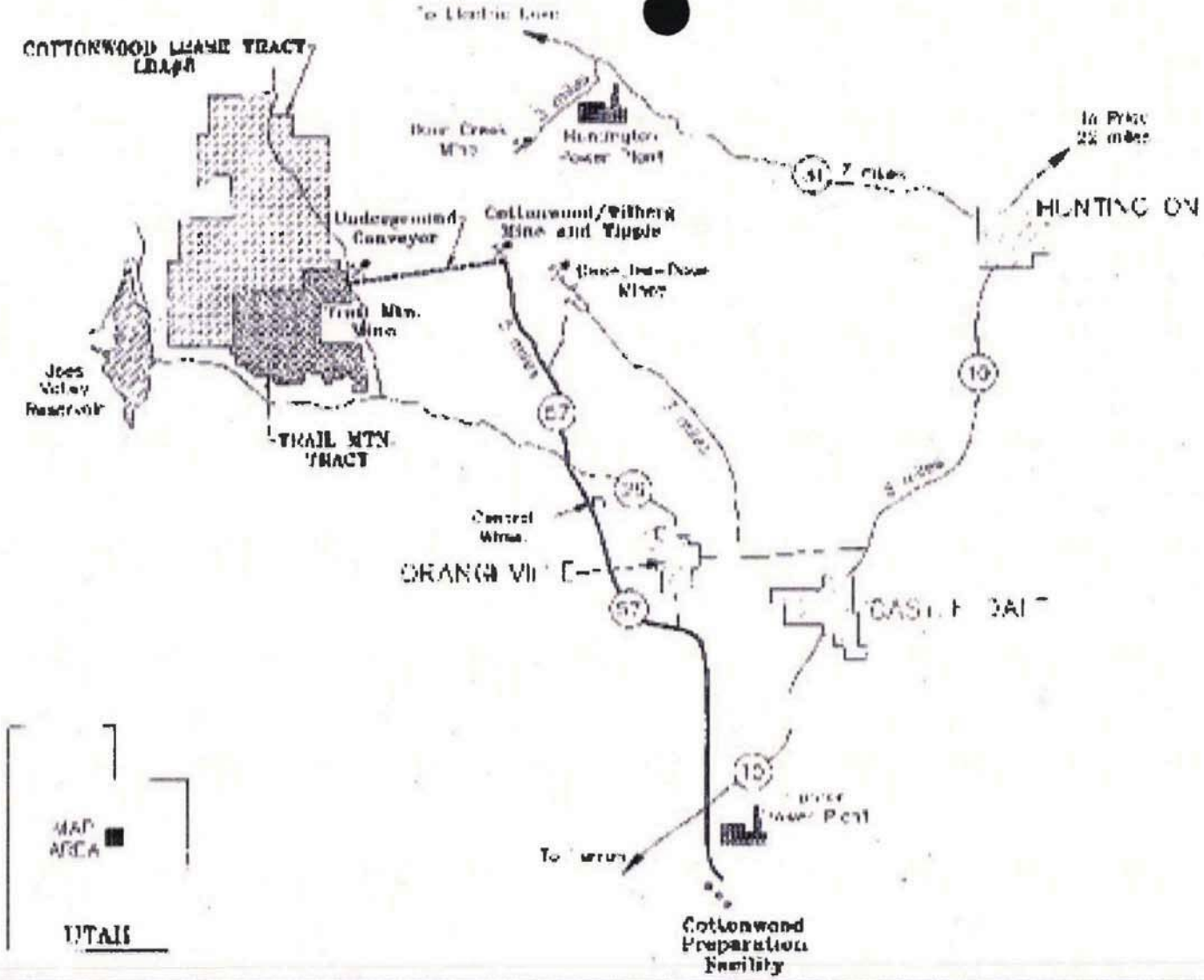
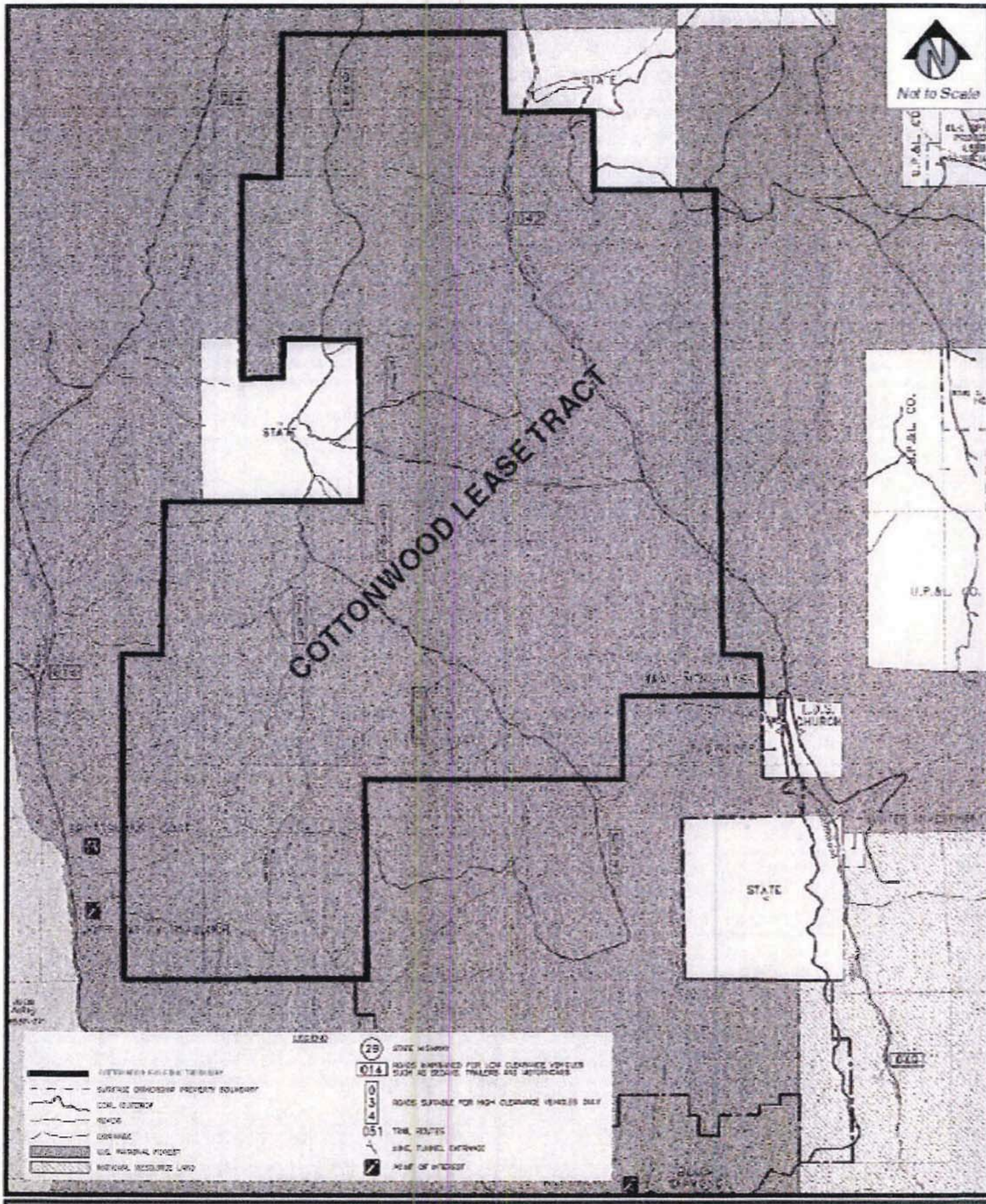



**SOURCE**

*Energy West Mining Company, May 21, 1998*

**Cottonwood Lease Tract EIS**
**Coal Flow**
**Mine to Hunter Power Plant**

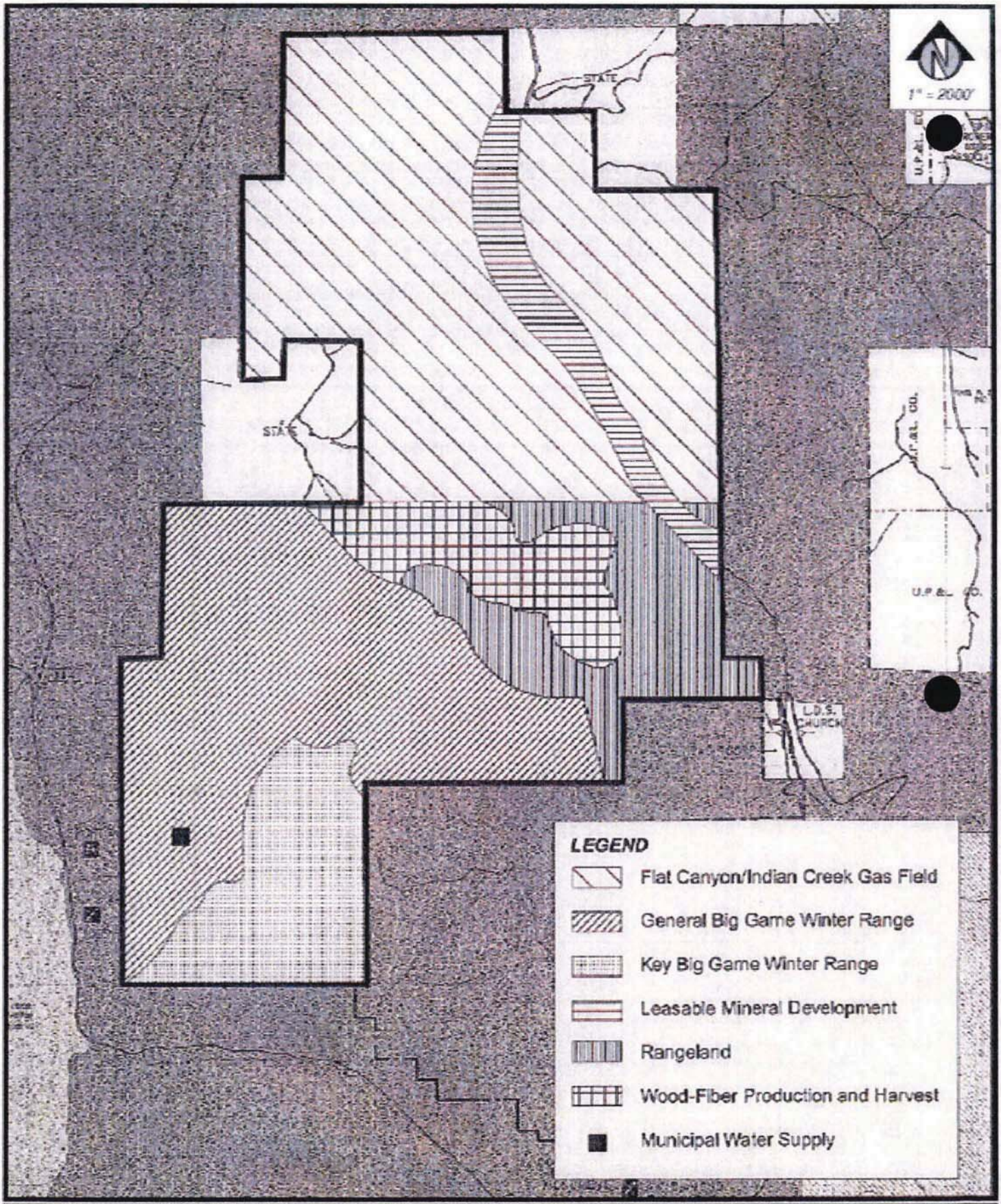
| | | |
|---|---|---|
| EMMCXXX01 | DAVID EVANS AND ASSOCIATES, INC. | FIG. 1.2-1 |
| May 1999 | | Sheet 1 of 1 |




**SOURCE**
*Energy West Mining Company, dated October 3, 1994.*

*Cottonwood Lease Tract EIS*
*Land Use/Surface Ownership*

| | | |
|---|---|---|
| EWMC0001 | | FIG. 3.12-1 |
| May 1999 | DAVID EVANS AND ASSOCIATES, INC. | Sheet 1 of 1 |




**SOURCE**

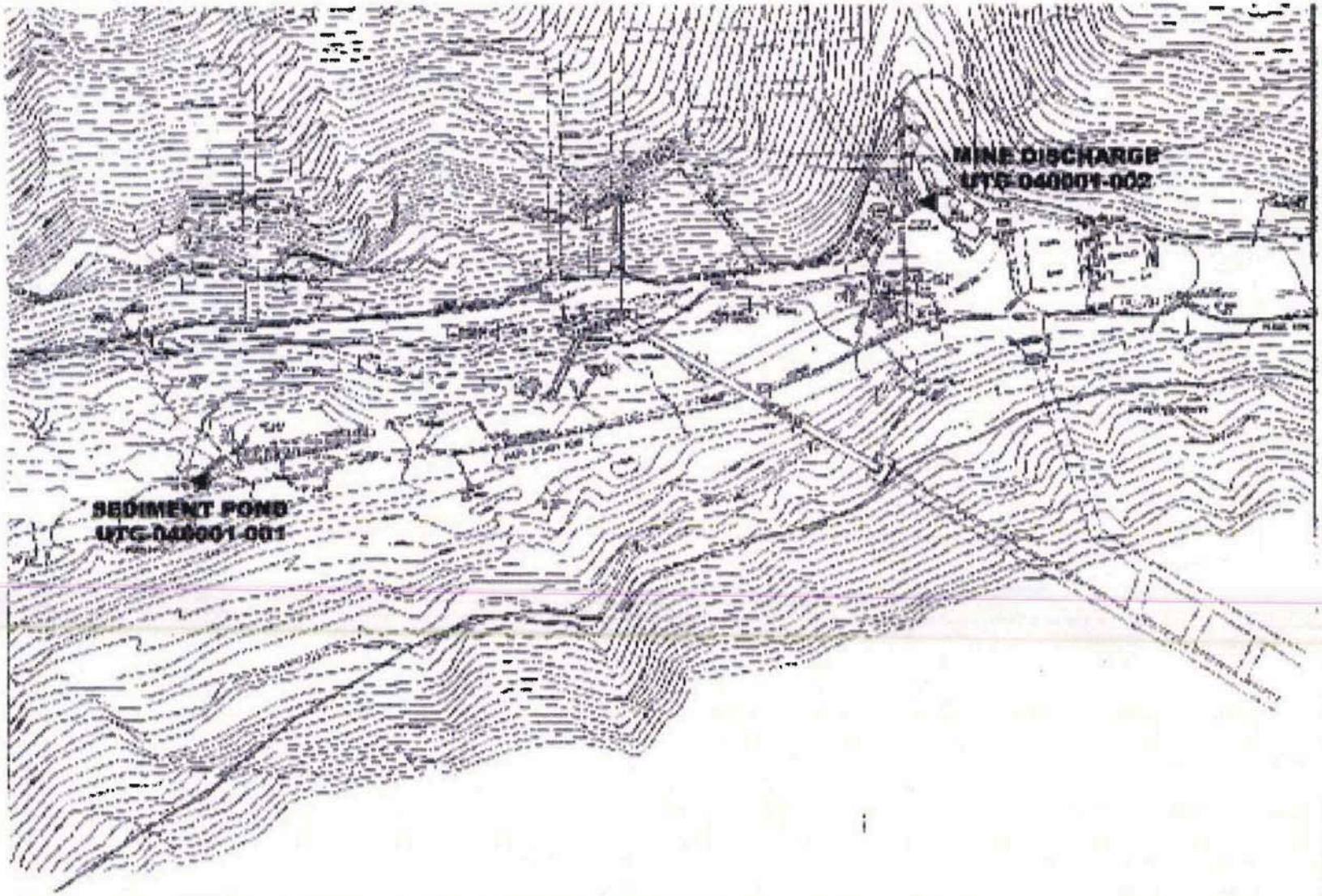
*Energy West Mining Company, February 27, 1996.*

**Cottonwood Lease Tract EIS**
**Forest Land and Resource Management Plan 1986**
**Management Units**

| | | |
|---|---|---|
| EWMC0001 | DAVID EVANS AND ASSOCIATES, INC. | FIG. 3.12-2 |
| May 1999 | | Sheet 1 of 1 |

Ref. Drafting/dv-1 ew/EWMC0001-Fig 3.12-2.dgn

Ref: Drafting\b-2ah\EWMC0001-Fig 3.12-3.dgn




Not to Scale

**SOURCE**

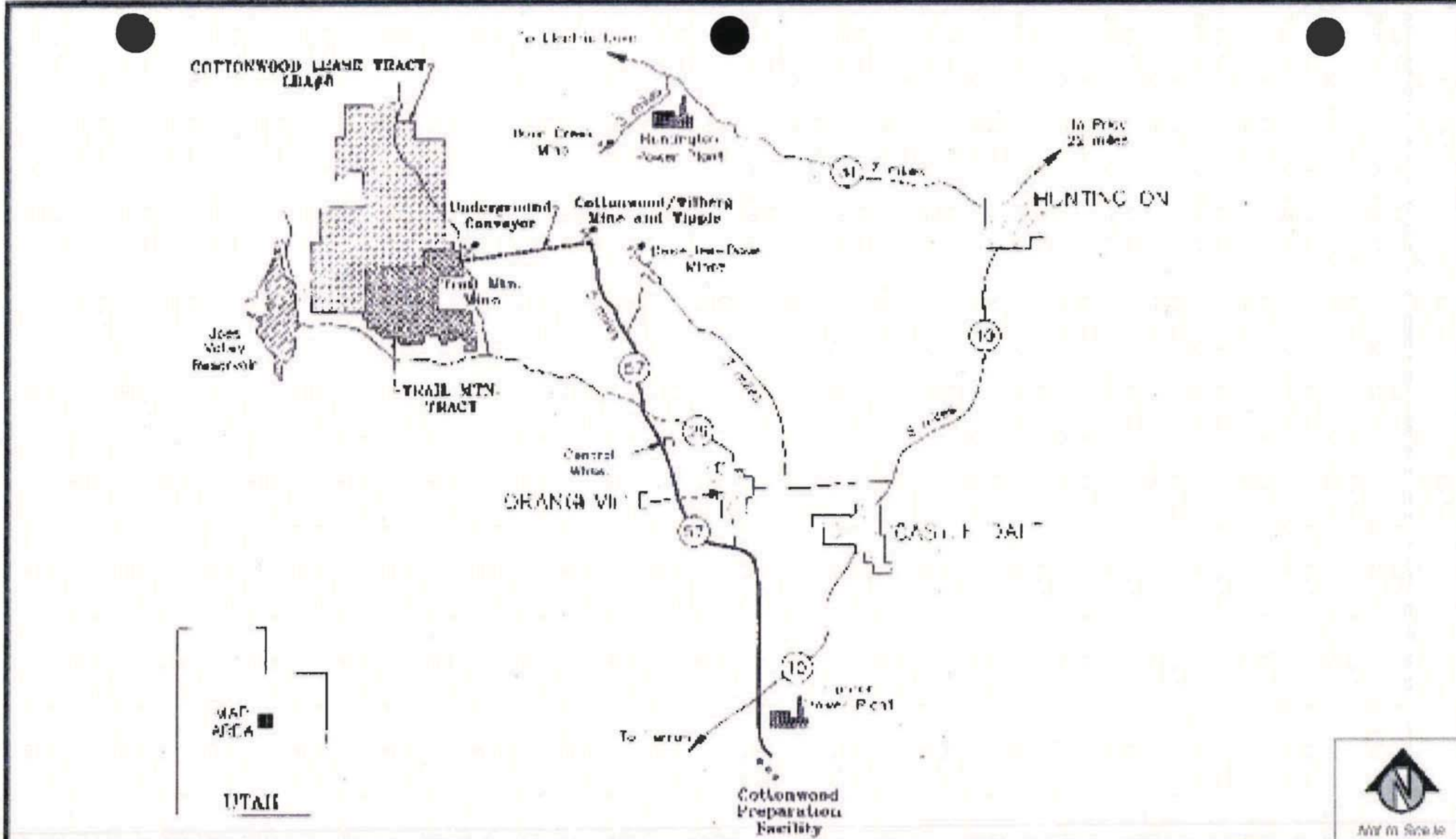
Energy West Mining Company, dated May 8, 1998

**LEGEND**

**Trail Mountain Mine**
**Surface Facility**
**Updes Discharge Locations**

| | | |
|---|---|---|
| EWMCXX01 | DAVID EVANS AND ASSOCIATES INC | RG. 3.12-3 |
| July 1998 | | Sheet 1 of 1 |

Ref: Drafting/tb-2ah/EWMC0001-Fig. 3.14-1.dsr




SOURCE

Energy West Mining Company, May 21, 1998

**Cottonwood Lease Tract EIS**
**Coal Flow**
**Mine to Hunter Power Plant**

| | | |
|---|---|---|
| EWMC0001 | | FIG. 3.14-1 |
| May 1999 | DAVID EVANS AND ASSOCIATES, INC. | Sheet 1 of 1 |

# APPENDIX 2-8-1

# BORROW AREA

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

# APPENDIX 8-1

# BORROW AREA

11/30/89

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

Trail Mountain minesite is a previously disturbed site since 1948. In 1981 plans were formulated to bring Trail Mountain Coal Company into a state of compliance in regards to sedimentation and drainage control structures. (i.e. Construction of new adequate sedimentation pond, 2,000 feet of 66 inch culvert, 200 feet of 48 inch culvert, inlet and outlet structures, expanded surface facilities area which include a borrow area, 1,800 feet of 15 inch half round culvert and storage and reclamation of topsoil).

With this construction, came the need for a borrow area to facilitate the construction of the sediment pond and to fill in the 2,000 feet of Cottonwood Creek that was culverted.

In early August of 1982, the Utah Division of Oil, Gas and Mining visited the mine site and gave approval to use the previously disturbed area just to the north of the bathhouse as a borrow area. (see Figure 3-16 and Appendix 3-1).

Prior to the Act, when the minesite was previously disturbed, the area just to the north of the bathhouse was disturbed in such a manner that a verticle highwall was left from the bathhouse north to the mine permit boundary. The use of this area as a borrow area served three major functions.

(1) The borrow area provided fill for culverting 2,000 feet of Cottonwood Creek and embankment for the sedimentation pond.

(2) Extracting fill material from the borrow area resulted in very needed storage and parking area.

(3) After removal of material from the borrow area was completed, proper and stable slopes were provided throughout the borrow area. (see Cross-Section Map)

The topsoil encountered in the borrow area was separated and removed pursuant to UMC 817.22. Topsoil that was separated and removed was promptly restored as a stable site adjacent to the mine portal. This storage was done pursuant to UMC 817.23. This area was reseeded and is permanently marked as topsoil. This material will remain in this location until it is required for redistribution on a disturbed area.

Topsoil material was transported from borrow area to storage site via a 988 cat frontend loader. At the storage location, a D-6 cat was used to push soil up an incline in approximately two foot lifts, taking every precaution against unnecessary compaction and contaminants.

The topsoil in storage, the fill material in Cottonwood Creek and the material in the sedimentation pond embankment will be removed and redistributed during final reclamation of the minesite.

Trail Mountain Coal Company has excavated the fill areas of Cottonwood Creek in three locations and the sediment pond embankment in one location to have the soils analyized. The resulting data can be found in the soils appendix.

2/1/88

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

It is the opinion of Trail Mountain Coal Company and Mount Nebo Scientific and the Soil Conversation Service (George Cook) that there will not be a need to import soil to the minesite to facilitate post mining reclamation.

2/1/88

APPENDIX 2-8-1 (L)

PRIME FARMLAND INVESTIGATION

# APPENDIX 8-1 (L)

# PRIME FARMLAND INVESTIGATION

11/15/90

United States Department of Agriculture
Soil Conservation Service
P.O. Box 11350
Salt Lake City, Utah 84147

December 4, 1990

Mel Coonrod
Reclamation Specialist
P.O. Box 358
Elmo, Utah 84521

Dear Mr. Coonrod:

In response to your request we are furnishing you with the Important Farmland determinations associated with the referenced project: "Trail Mountain No. 9 Mine."

No Important Farmlands were identified in the project area. The soils are eliminated for the following reasons:

(1) Steep slopes - most soils in the area are eliminated by having K (erodibility factor) X percentage of slope having a greater value than 2.

(2) Stony surfaces - stones comprise more than 10 percent of the soil.

(3) Cryic temperature regime - The cold temperatures eliminate soils as having a cryic temperature regime.

(4) Shallow soils - soils with depths less than 4.0 inches.

We are retaining copies of the enclosed map and associated data for future reference.

Should you have additional questions concerning the evaluations, please call on us.

Sincerely,

Ferris P. Allgood
State Soil Scientist

cc:
Jan Anderson, DC, SCS, Price, Utah

# APPENDIX 2-8-2

# SOILS AND VEGETATION TEST PLOT MONITORING

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

# APPENDIX 8-2

# SOILS AND VEGETATION

# TEST PLOT MONITORING

NOVEMBER 1987

7/15/88

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

# SOILS AND VEGETATION

## TEST PLOT MONITORING

NOVEMBER 1987

(SEE APPENDIX 9-2)

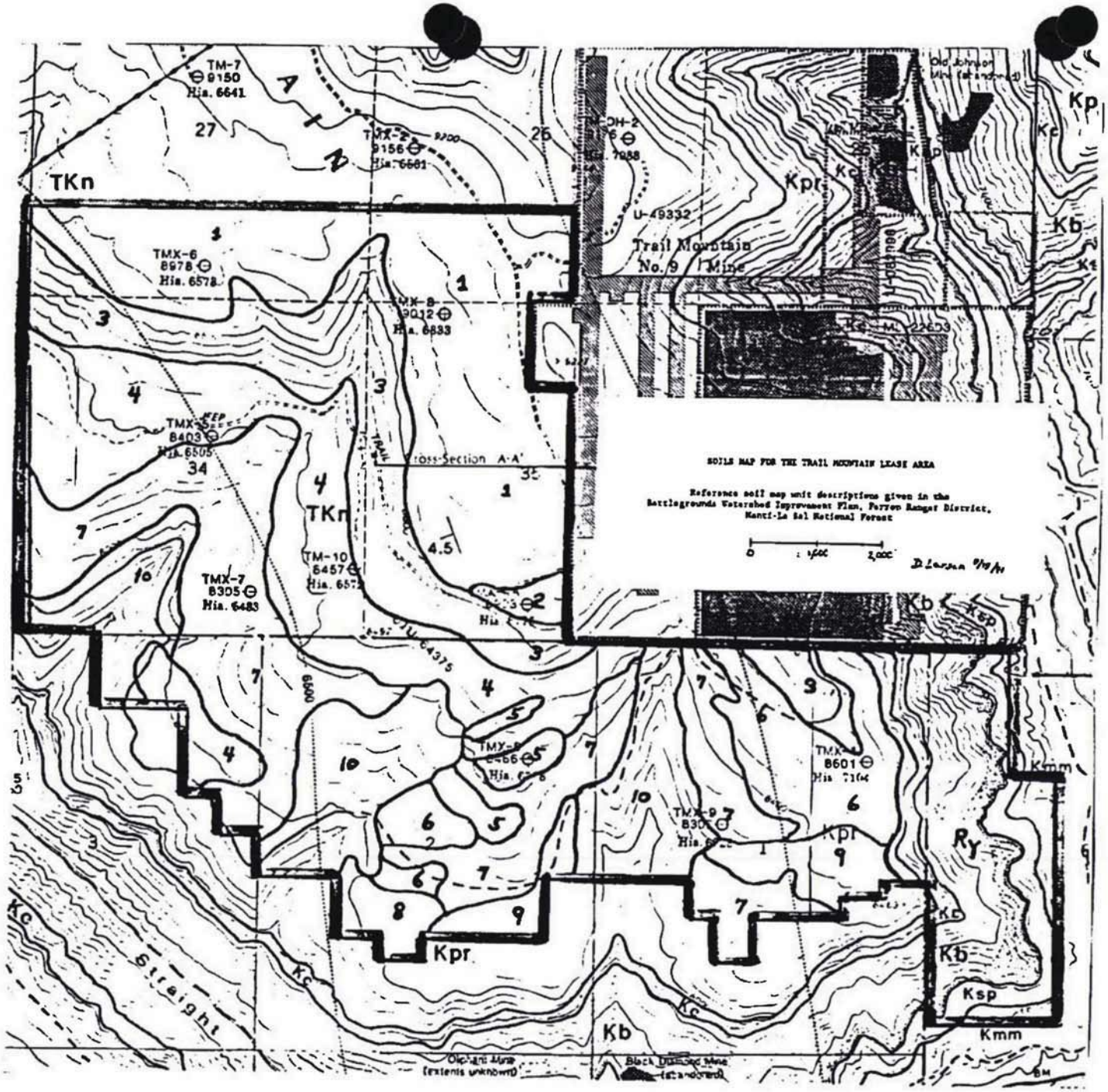
7/15/88

APPENDIX 2-8-2 (L)

SOILS MAP AND DESCRIPTION

**APPENDIX 8-2(L)**

**SOILS MAP AND DESCRIPTIONS**


SOILS MAP FOR THE TRAIL MOUNTAIN LEASE AREA
Reference soil map unit descriptions given in the
Battlegrounds Watershed Improvement Plan, Ferron Ranger District,
Manti-La Sal National Forest
Trail Mountain
No. 9 Mine
Cross-Section A-A'
TKn
TKf
Kpr
Kb
Kc
Ksp
Kmm
Ry
Kp
TM-7
9150
Hia. 6641
TMX-6
8978
Hia. 6578
TMX-8
9012
Hia. 6833
TMX-5
8403
Hia. 6505
TM-10
8457
TMX-7
8305
Hia. 6483
TMX-9
8601
Straight
Old Johnson Mine (extents unknown)
Black Diamond Mine (collapsed)

Road access to the upper part of the project will be by the Trail Mountain Road (034). Access to the lower part of the project will be by the Trail Mountain road and South Trail S&W access road. Approximately one mile of temporary road will need to be constructed for access. About one-fourth mile of this road will be across State land. All temporary roads will be closed and seeded at the end of the project.

G. Soil and Hydrologic Evaluation

General: The areas proposed for treatment are suffering from extensive sheet and gully erosion. Snow melt water and runoff from summer thunderstorms is transported quickly overland to gully systems that feed Straight Canyon Creek. Runoff waters carry an extremely heavy load of sediment directly into the stream in Straight Canyon.

Water movement and interactions with the landscape and vegetation in the Battlegrounds are strongly influenced by the climate and topography of the area.

The inherent erosion hazard for bare soil conditions in the Battlegrounds area is moderate. A moderate hazard specifies sufficient resistance to erosion to permit limited and temporary exposure of the bare soil during mechanical treatment.

Using R.K. Tew's guide on Estimating Soil Erosion Losses from Utah Watersheds (1973), the current soil loss from the proposed Battlegrounds treatment area ranges from .03 to .06 inches per year. Conversions to tons per acre gives values of about 4.5 to 9.0 respectively.

An order 2 soil survey was conducted in the area by Dan Larsen, Forest Soil Scientist. A soils map made on a 1:15, 840 scale aerial photograph is presented in Appendix III. Descriptions of the soil map units are given below:

1. This soil map unit is located on the gentle slopes above the escarpment (M.U. 3). The soils have a dark reddish-brown colored, silty clay loam surface layer about 10 to 20 inches thick over a yellowish-brown clay which ranges in depth from 10 to 26 inches. Below 26 inches is a greyish colored clay. The soils support dominantly grass. Slopes are 5 to 15 percent. A few clayey eroded spots occur within the unit, and gullies are present at established drainages. This unit is proposed for treatment.

   The Hydrologic Soil Group is D; the Runoff Curve Number is estimated at 93; the runoff from the 6 hour 50 year recurrence interval storm is estimated to be 1.3 inches.

2. This unit occurs near the upper edge of the escarpment. Soils are shallow and stoney. Sandstone rock outcrops and eroded shale exposures are included. Vegetation consists of pinyon-juniper, mountain mahogany, and limber pine. No treatment is planned.

3. This is a steeply sloping escarpment. Soils are shallow to moderately deep and stoney. Slopes are 40 to 65 percent. Vegetation includes pinyon-juniper and mountain brush. The site is droughty due to the steep, southfacing slopes and rapid runoff. Runoff from this soil unit contributes to soil erosion downslope, especially in M.U. 4. No treatment is planned.

4. These soils have formed on alluvial and colluvial deposits below the escarpment (M.U.3). They receive moisture from runoff upslope as well as on-site precipitation. The soils typically have a dark brown loam surface layer that is 8 to 18 inches thick. This is underlain by a clay loam subsoil, which typically has a calcium carbonate accumulation starting at a depth of about 18 inches. Rock fragments, mostly gravel and cobble, make up 10 to 40 percent at the soil profile. Vegetation is dominantly serviceberry, pinyon-juniper, sagebrush, and grasses. Slopes are 10 to 20 percent. This soil unit has some of the best soils for treatment in the Battlegrounds area. Erosion is primarily in the form of gullies ranging from 2 to 5 feet in depth. This unit is proposed for treatment.

   The Hydrologic Soil Group is C and B; the Runoff Curve Number is estimated at 87; the runoff from the 6 hour 50 year recurrence interval storm is estimated to be 0.92 inches.

5. These soils have a thin brown surface over a highly carbonaceous subsoil.

   The soils commonly have a high gravel content at the surface. Textures range from sandy loam to clay loam. Vegetation includes black sagebrush with relatively sparce forbs and grasses. Slopes are 10 to 25 percent. Sheet erosion is prevalent on these soils. Contour furrowing would be a good measure to control surface runoff, however the production of vegetation is expected to be low.

   The Hydrologic Soil Group is C and D; the Runoff Curve Number is estimated at 93; the runoff from the 6 hour 50 year recurrence interval storm is estimated to be 1.3 inches.

6. This unit has shallow to moderately deep (12 to 40 inches) soils on slopes of 15 to 40 percent. Steep slope pitches and benches are present. Soils on the steeper portions are shallow over shale and quite stoney. On the gentler slopes, the soils are deeper, darker colored, and support more vegetation. Soil

textures are silt loam to clay in the subsoils. Topsoil thickness varies from about 3 to 12 inches. Vegetation includes pinyon-juniper, sagebrush and grasses. Sheet, rill, and gully erosion is occurring within this soil unit. The sheet and rill erosion dominates a shallow soil on steep slopes, and the gullies are typical where soils are deeper and slopes are in the 15-20 percent range. This unit is proposed for treatment.

The Hydrologic Soil Group is B; the Runoff Curve Number is estimated at 78; the runoff from the 6 hour 50 year recurrence interval storm is estimated to be 0.5 inches.

7. This map unit consists of shallow to moderately deep soils supporting dominantly pinyon-juniper stands on 15 to 35 percent slopes. Topsoil layers are thin and have loam to sandy loam textures. Subsoils are clay loam or sandy loam.

   The Hydrologic Soil Group is C; the Runoff Curve Number is estimated at 90; the runoff from the 6 hour 50 year recurrence interval storm is estimated at 1.0 inches.

8. This map unit lies below some steeper slopes where erosion is active. Overall, it is a zone of soil accumulation as sediments are deposited. However, one major gully has cut through the unit where runoff is concentrated. The soils have a thick dark colored loam surface, often 15 to 24 inches thick. Subsoils range from a gravelly loam to a clay loam and typically have accumulation of calcium carbonate. These soils support dominantly sagebrush and grass. Slopes are 8 to 15 percent. There is a good potential for revegetation. This unit is proposed for treatment.

   The Hydrologic Soil Group is B; the Runoff Curve Number is estimated at 78; the runoff from the 6 hour 50 year recurrence interval storm is estimated to be 0.5 inches.

9. These soils are shallow to moderately deep over sandstone and shale on slopes of about 5 to 20 percent. They support mostly sagebrush (including some black sagebrush) and grasses with some scattered pinyon and juniper. The soils typically have a loam to sandy loam surface soil over a finer texture subsoil which is clay loam or clay. The soils are quite variable within the unit, differing primarily in texture, depth, and rock fragment content. Shallow clayey soils are common on black sagebrush sites, and shallow stoney soils are common where pinyon-juniper is present. A portion of this unit is planned for treatment.

   The Hydrologic Soil Group is C; the Runoff Curve Number is estimated at 87; the runoff from the 6 hour 50 year recurrence interval storm is estimated to be 0.92 inches.

10. This unit consists of steeply sloping lands with shallow, stoney soils supporting pinyon and juniper. Slopes are 30 to 70 percent. Rock outcrops are common. This unit is not proposed for treatment.

There are no identified wet lands or flood plains in the treatment area.

H. Watershed Condition Improvements

There is a total of 606 acres proposed for various forms of treatment within the project area. The amount of treatment is shown below and on the project map.

Table I Amount of Treatment

| | |
|---|---|
| Contour furrow | 566 acres |
| Contour trench | 40 acres |
| Protection fence | 1 mile |
| Gully swaling | 6,000 feet |
| Gully plugs | 17 double fence dams |

The trench and furrow spacing is determined from the equation in: Sediment Reduction Through Watershed Rehabilitation, by Edward E. Noble, USDA - Forest Service, Intermountain Region, 1963. Page 16.

$$\frac{\text{Runoff (in.)}}{12\ \frac{\text{inches}}{\text{ft.}}} \times \text{furrow interval (ft.)} = \text{furrow capacity } \left(\frac{\text{ft.}^3}{\text{ft.}}\right)$$

From the map unit descriptions the greatest runoff from the 6 hour 50 year storm event is 1.3 inches. The furrow construction method produces a capacity of 5.4 $ft.^3/ft.$ (How to Treat a Watershed, by Darell Stewart, Manti-LaSal National Forest, Price, Utah, 1982, Page 59). Using the previous equation:

$$\frac{1.3\ \text{inches}}{12\ \frac{\text{inches}}{\text{ft.}}} \times 50\ \text{ft.} = 5.4\ \frac{\text{ft.}^3}{\text{ft.}}$$

Therefore, a spacing of 50 feet between furrows will provide sufficient storage for the 6 hour 50 year storms. A reduced spacing of 40 feet which is planned will provide some freeboard.

Spacing of the furrows will vary from area to area because of slope, soil conditions and ground cover. They will be constructed with a D-7 crowler tractor with a hydraulic blade. If available, a Vari-dozer would be preferable.

## SOIL CLASSIFICATION - BATTLEGROUNDS

Map Unit

Argic Pachic Cryoborolls, fine, montmorillonitic

1. Argic Cryoborolls, fine, montmorillonitic

2. Lithic Ustortherts, loamy-skeletal, mixed

   Typic Argiborolls, loamy-skeletal, mixed

   Rock outcrop: Sandstone and shale

3. Typic Ustorthents, loamy-skeletal, mixed

   Typic Ustochrepts, loamy-skeletal, mixed

4. Typic Argiborolls, fine-loamy, mixed

   Typic Argiborolls, loamy-skeletal, mixed

   Pachic Argiborolls, fine-loamy, mixed

5. Typic Ustochrepts, fine-loamy, mixed

6. Typic Ustorthents fine-loamy, shallow, mixed

   Typic Ustorthents, loamy-skeletal, mixed

   Typic Argiborolls, loamy-skeletal, shallow mixed

7. Lithic Eutroboralfs, loamy-skeletal, mixed

   Lithic Argiborolls, loamy-skeletal, mixed

   Typic Ustorthents, fine-loamy, shallow, mixed

8. Cumulic Haploborolls, fine-loamy, mixed

9. Typic Argiborolls, fine-loamy, mixed

   Lithic Argiborolls, loamy-skeletal, mixed

   Cumulic Haploborolls, fine-loamy, mixed

10. Lithic Ustorthents, loamy-skeletal, mixed

    Typic Ustorthents, fine-loamy, shallow

    Rock outcrop

Ry - Steep rocky slopes with shallow soils.

# BATTLEGROUNDS WATERSHED IMPROVEMENT PLAN

## FERRON RANGER DISTRICT
## MANTI-LASAL NATIONAL FOREST

Prepared by: John Niebergall, District Ranger
Bill Dye, Forester
Dan Larsen, Soil Scientist
Dennis Kelly, Hydrologist

Recommended by: John Niebergall — District Ranger — 6-26-85 — Date

Watershed Staff — 8/16/85 — Date

Approved by: Forest Supervisor — 8/19/85 — Date

# APPENDIX 2-8-3

# POST-GRADING SAMPLING PROGRAM

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

# APPENDIX 8-3

# POST - GRADING SAMPLING PROGRAM

7/15/88

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

ATTACHMENT C

OFFICE OF SURFACE MINING STIPULATIONS

PLAN FOR SAMPLING THE REGRADED SURFACE OF THE TRAIL MOUNTAIN MINE SITE TO CONFIRM SALINITY VALUES ARE NOT EXCEEDED.

7/15/88

(Revised for Chapter 8 by recommendations from DOGM)

# PLAN FOR SAMPLING THE REGRADED SURFACE OF THE TRAIL MOUNTAIN MINE SITE TO CONFIRM SALINITY VALUES ARE NOT EXCEEDED

The following is a revised version of the above with recommendations incorporated from Dan Duce (Soils Specialist, DOGM) from a memo dated February 24, 1988 to John Whitehead (Permit Supervisor, DOGM). These recommendations were also referred to in a letter from John Whitehead to Dan Guy (Beaver Creek Coal Company) date May 27, 1988.

## POST-GRADING SOIL SAMPLING

Soil sampling will be conducted at the time of final reclamation after earthmoving and recontouring procedures and prior to the seedbed preparation techniques (see Appendix 9 for more on reclamation and revegetation techniques). One goal of the earth moving procedures is to place the substitute soil so that the top 12 inches of the growing media has EC values of 8 mmhos/cm (or less) and the underlying 36 inches of soils have values less that 16 mmhos/cm. Soil sampling will provide a method to determine if these objectives are met.

## SAMPLING DESIGN

Soil sample locations will be determined by a grid sampling design, placed at regular intervals on the grid. Distance between sample locations will be no more than 100 feet over the entire disturbed area. At each sample grid location three (3) composite soil samples will be collected: one sample from the top 12 inches and two samples from the underlying 36 inches. Each sample will then be analyzed at a soils laboratory for their EC values. If the EC values exceed the above limits, additional sampling may be necessary to locate the exact area of the problem soils so that mitigation may be implemented. A Subset of 20-30 of these samples will be randomly picked and also be analyzed for fertility to be used for fertilization and recommendations (see "Fertilization", Appendix 9).

APPENDIX 2-8-4

SUMMARY OF SOIL ANALYSIS (1981-1987)

# APPENDIX 8-4

# SUMMARY
# of

# SOILS ANALYSIS
# (1981 - 1987)

2/21/90

## NOTES FOR REVISED TABLE 6

As requested by the Division of Oil, Gas & Mining (and for clarification reasons), the table on the following pages replaces the laboratory certified Table 6. In a memorandum to John Whitehead (Permit Supervisor - DOGM) from Dan Duce (Soils Specialist - DOGM) dated February 24, 1988, it was recommended that "all soil analyses taken to date on the spoils and natural soils should be shown in tabular from: parameters, sample number, depth and location (as in Tables on pages 17F-H)". It was also requested that "impertinent material" be deleted from the report.

As a result, the following table shows the data of all analyses between 1981 and 1987. A history of the soil sampling to date was submitted in Appendix 9-2 by P. Collins entitled "SOIL AND VEGETATION TEST PLOT MONITORING AT THE TRAIL MOUNTAIN COAL MINE: 1987 UPDATE".

Listed below is a key to the symbols for the location column of the table. The sample locations are also shown on Map A (as recommended by D. Duce in the above memorandum).

a = Coal storage area, borrow spoils.
b = Native undisturbed soils
c = Disturbed, borrow spoils
d = Rip-rap medium
e = Native, slightly disturbed, but uncontaminated by mining activities
f = Disturbed soils
g = Native, slightly disturbed, BLM property soils
h = Vegetation test plot soils, Mixture I
i = Vegetation test plot soils, Mixture II
S = Spoils (used for statistical comparisons)
N = Native soils (used for statistical comparisons)
T = Vegetation test plot spoils

Revised TABLE 6: Summary of results from all soil analyses (1981 - 1987) of the Trail Mountain #9 Mine, Emery County, Utah. Note that there are some duplicate sample numbers, but sample depths differentiate these.

| SAMPLE NUMBER | COLL. DATE | LOCA-TION | DEPTH (FT.) | EC x 10^3 | SAR | pH | CEC | %OM | %MOIS-TURE | %Ca CO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1983 | a,S | 0.0 | 8.20 | 4.56 | 7.9 | 11.6 | 2.75 | 26.29 | 44.5 |
| 2 | 1983 | a,S | 2.0 | 4.95 | 2.65 | 7.6 | 11.4 | 2.36 | 25.46 | 28.7 |
| 3 | 1983 | a,S | 4.0 | 5.90 | 2.92 | 7.8 | 9.9 | 2.07 | 23.54 | 33.1 |
| 4 | 1983 | a,S | 6.0 | 7.50 | 4.49 | 7.6 | 14.4 | 4.75 | 29.64 | 39.8 |
| 5 | 1983 | a,S | 8.0 | 6.70 | 4.34 | 7.9 | 13.2 | 4.08 | 32.26 | 33.9 |
| 6 | 1983 | a,S | 0.0 | 1.85 | 4.97 | 8.2 | 11.0 | 5.35 | 30.65 | 37.1 |
| 7 | 1983 | a,S | 2.0 | 9.80 | 3.29 | 8.4 | 12.8 | 4.92 | 31.04 | 32.3 |
| 8 | 1983 | a,S | 4.0 | 11.40 | 4.31 | 8.7 | 11.0 | 2.89 | 32.61 | 40.1 |
| 9 | 1983 | a,S | 6.0 | 14.80 | 8.47 | 7.8 | 10.2 | 2.90 | 26.17 | 37.9 |
| 10 | 1983 | a,S | 8.0 | 12.50 | 5.28 | 7.9 | 9.5 | 1.80 | 26.29 | 35.5 |
| 11 | 1983 | a,S | 10.0 | 10.00 | 7.66 | 8.0 | 17.0 | 2.37 | 26.85 | 39.2 |
| 12 | 1983 | a,S | 0.0 | 37.00 | 23.50 | 7.6 | 30.8 | 9.84 | 37.94 | 43.5 |
| 13 | 1983 | a,S | 3.0 | 17.00 | 12.90 | 7.7 | 11.8 | 8.48 | 12.58 | 37.6 |
| 14 | 1983 | a,S | 6.0 | 11.40 | 12.60 | 7.9 | 33.0 | 6.52 | 33.02 | 43.1 |
| 15 | 1983 | a,S | 9.0 | 8.40 | 6.30 | 7.8 | 13.0 | 3.50 | 32.26 | 42.3 |
| 16 | 1983 | a,S | 12.0 | 36.50 | 36.80 | 7.7 | 13.0 | 5.57 | 31.10 | 34.9 |
| 17 | 1983 | a,S | 0.0 | 7.00 | 15.20 | 8.1 | 6.9 | 2.19 | 31.50 | 35.2 |
| 18 | 1983 | a,S | 2.0 | 11.80 | 10.40 | 7.7 | 10.4 | 2.36 | 29.63 | 29.2 |
| 19 | 1983 | a,S | 4.0 | 18.40 | 20.10 | 7.9 | 7.9 | 4.08 | 36.80 | 36.2 |
| 20 | 1983 | a,S | 6.0 | 9.90 | 6.25 | 8.2 | 11.6 | 2.96 | 41.74 | 44.6 |
| 21 | 1983 | a,S | 8.0 | 11.00 | 12.70 | 8.0 | 8.3 | 2.33 | 30.53 | 33.6 |
| 22 | 1983 | b,N | 0.0 | 1.95 | 1.54 | 7.9 | 11.6 | 3.47 | 26.97 | 39.6 |
| 23 | 1983 | c,S | 0.0 | 5.20 | 3.78 | 8.3 | 12.0 | 1.98 | 33.06 | 49.5 |
| 24 | 1983 | d,S | 0.0 | 4.50 | 6.25 | 7.8 | 10.4 | 5.62 | 30.53 | 37.3 |
| 25 | 1983 | d,S | 0.0 | 4.00 | 12.70 | 8.1 | 9.3 | 1.66 | 29.71 | 39.5 |
| 26 | 1984 | e,N | 0.0 | 2.38 | 1.94 | 7.9 | — | — | — | — |
| 26 | 1984 | e,N | 2.0 | 5.20 | 3.49 | 7.8 | — | — | — | — |
| 27 | 1984 | e,N | 0.0 | 1.16 | .95 | 7.9 | — | — | — | — |
| 28 | 1984 | f,S | 0.0 | 5.30 | 1.94 | 6.8 | — | — | — | — |
| 28 | 1984 | f,S | 2.0 | 5.68 | 2.17 | 7.2 | — | — | — | — |
| 29 | 1984 | b,N | 0.0 | 0.42 | 0.40 | 7.9 | — | — | — | — |
| 29 | 1984 | b,N | 2.0 | 0.49 | 0.37 | 8.1 | — | — | — | — |
| 30 | 1984 | a,S | 2.0 | 11.50 | 6.36 | 8.0 | — | — | — | — |
| 30 | 1984 | a,S | 4.0 | 15.70 | 6.34 | 8.3 | — | — | — | — |
| 30 | 1984 | a,S | 6.0 | 11.50 | 4.89 | 8.3 | — | — | — | — |
| 30 | 1984 | a,S | 8.0 | 11.80 | 3.59 | 8.2 | — | — | — | — |
| 30 | 1984 | a,S | 10.0 | 11.40 | 3.58 | 8.3 | — | — | — | — |
| 31 | 1984 | a,S | 2.0 | 4.80 | 3.39 | 8.5 | — | — | — | — |
| 31 | 1984 | a,S | 4.0 | 5.18 | 2.74 | 8.5 | — | — | — | — |
| 31 | 1984 | a,S | 6.0 | 7.02 | 2.16 | 8.7 | — | — | — | — |
| 31 | 1984 | a,S | 8.0 | 7.72 | 2.10 | 8.6 | — | — | — | — |
| 31 | 1984 | a,S | 10.0 | 9.40 | 1.48 | 8.2 | — | — | — | — |
| 32 | 1984 | a,S | 2.0 | 5.65 | 3.88 | 8.0 | — | — | — | — |
| 32 | 1984 | a,S | 4.0 | 7.66 | 2.72 | 7.5 | — | — | — | — |
| 32 | 1984 | a,S | 6.0 | 8.55 | 2.73 | 7.6 | — | — | — | — |
| 32 | 1984 | a,S | 8.0 | 9.10 | 2.59 | 8.0 | — | — | — | — |
| 32 | 1984 | a,S | 10.0 | 10.90 | 2.44 | 8.0 | — | — | — | — |

Soil Analyses (1981 - 1987)
Trail Mountain #9 Mine

| SAMPLE NUMBER | COLL. DATE | LOCATION | DEPTH (FT.) | EC x 10^3 | SAR | pH | CEC | %OM | %MOISTURE | %Ca CO |
|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 1984 | a,S | 12.0 | 9.85 | 3.80 | 7.8 | -- | -- | -- | -- |
| 33 | 1984 | a,S | 2.0 | 8.50 | 2.85 | 7.2 | -- | -- | -- | -- |
| 33 | 1984 | a,S | 4.0 | 8.70 | 3.44 | 7.2 | -- | -- | -- | -- |
| 33 | 1984 | a,S | 6.0 | 7.48 | 3.17 | 7.2 | -- | -- | -- | -- |
| 33 | 1984 | a,S | 8.0 | 7.62 | 2.41 | 7.3 | -- | -- | -- | -- |
| 33 | 1984 | a,S | 10.0 | 11.30 | 7.87 | 7.6 | -- | -- | -- | -- |
| 34 | 1984 | g,N | 2.0 | 6.38 | 5.38 | 7.6 | 18.3 | 0.98 | 33.35 | 20.70 |
| 34 | 1984 | g,N | 4.0 | 7.90 | 7.40 | 7.7 | 24.3 | 0.67 | 30.94 | 30.90 |
| 34 | 1984 | g,N | 6.0 | 9.75 | 10.50 | 7.7 | 10.0 | 0.80 | 32.83 | 33.79 |
| 34 | 1984 | g,N | 8.0 | 6.38 | 5.01 | 7.7 | 6.4 | 0.51 | 30.85 | 17.62 |
| 34 | 1984 | g,N | 10.0 | 8.60 | 8.42 | 7.8 | 8.0 | 0.83 | 30.49 | 26.26 |
| 35 | 1984 | g,N | 2.0 | 9.15 | 9.93 | 7.8 | 10.0 | 0.85 | 32.33 | 21.98 |
| 35 | 1984 | g,N | 4.0 | 9.24 | 9.85 | 7.9 | 19.1 | 0.77 | 32.99 | 27.24 |
| 35 | 1984 | g,N | 6.0 | 9.30 | 9.16 | 7.6 | 10.5 | 0.89 | 31.73 | 20.94 |
| 35 | 1984 | g,N | 8.0 | 6.50 | 6.13 | 7.5 | 11.3 | 1.23 | 31.42 | 30.32 |
| 35 | 1984 | g,N | 10.0 | 2.26 | 0.90 | 7.8 | 9.2 | 0.68 | 29.91 | 30.30 |
| 36 | 1981 | b,N | 0.4 | 9.00 | 0.08 | 8.2 | 9.0 | -- | -- | -- |
| 36 | 1981 | b,N | 0.9 | 8.20 | 0.07 | 8.3 | 8.2 | -- | -- | -- |
| 36 | 1981 | b,N | 1.1 | 7.60 | -- | 8.5 | 7.6 | -- | -- | -- |
| 36 | 1981 | b,N | 1.3 | 4.50 | -- | 8.7 | 4.5 | -- | -- | -- |
| 36 | 1981 | b,N | 1.7 | 6.30 | -- | 8.7 | 6.3 | -- | -- | -- |
| 37 | 1981 | b,N | 0.8 | 13.30 | 0.08 | 8.0 | 13.3 | -- | -- | -- |
| 37 | 1981 | b,N | 1.1 | 8.30 | -- | 8.3 | 8.3 | -- | -- | -- |
| 37 | 1981 | b,N | 1.3 | 10.00 | 0.22 | 8.2 | 10.0 | -- | -- | -- |
| 37 | 1981 | b,N | 1.5 | 6.60 | -- | 8.4 | 6.6 | -- | -- | -- |
| 37 | 1981 | b,N | 2.1 | 22.80 | 0.24 | 8.2 | 22.8 | -- | -- | -- |
| 37 | 1981 | b,N | 3.0 | 18.50 | 0.18 | 8.2 | 18.5 | -- | -- | -- |
| 37 | 1981 | b,N | 3.4 | 8.20 | 0.18 | 8.0 | 8.2 | -- | -- | -- |
| 37 | 1981 | b,N | 1.2 | 10.00 | 0.29 | 8.0 | 10.8 | -- | -- | -- |
| 38 | 1987 | h,T | 0.5 | 1.26 | 0.63 | 7.7 | 14.3 | 4.45 | 33.91 | 52.39 |
| 39 | 1987 | h,T | 1.5 | 3.02 | 2.96 | 7.9 | -- | -- | -- | -- |
| 40 | 1987 | h,T | 0.5 | 1.14 | 0.60 | 7.8 | 13.9 | 3.45 | 31.84 | 52.67 |
| 41 | 1987 | h,T | 1.5 | 2.45 | 1.73 | 7.4 | -- | -- | -- | -- |
| 42 | 1987 | h,T | 0.5 | 1.34 | 1.19 | 7.7 | 13.4 | 2.99 | 32.48 | 54.28 |
| 43 | 1987 | h,T | 1.5 | 1.49 | 2.57 | 8.3 | -- | -- | -- | -- |
| 44 | 1987 | i,T | 0.5 | 1.32 | 0.70 | 7.8 | 13.8 | 2.63 | 32.20 | 51.87 |
| 45 | 1987 | i,T | 1.5 | 3.52 | 4.55 | 7.7 | -- | -- | -- | -- |
| 46 | 1987 | i,T | 0.5 | 1.08 | 0.99 | 7.9 | 13.7 | 3.96 | 32.35 | 49.92 |
| 47 | 1987 | i,T | 1.5 | 1.13 | 1.79 | 7.8 | -- | -- | -- | -- |
| 48 | 1987 | i,T | 0.5 | 1.40 | 0.62 | 7.6 | 14.8 | 3.88 | 35.29 | 54.62 |
| 49 | 1987 | i,T | 1.5 | 4.05 | 4.60 | 7.6 | -- | -- | -- | -- |
| 50 | 1987 | h,T | 2.0 | 2.75 | 2.69 | 7.9 | -- | -- | -- | -- |
| 51 | 1987 | h,T | 4.0 | 2.90 | 6.21 | 8.3 | -- | -- | -- | -- |
| 52 | 1987 | h,T | 6.0 | 2.48 | 2.27 | 8.4 | -- | -- | -- | -- |
| 53 | 1987 | h,T | 8.0 | 6.55 | 3.78 | 8.1 | -- | -- | -- | -- |

Soil Analyses (1981 - 1987)
Trail Mountain #9 Mine

| NO. | %SAND | %CLAY | %SILT | PPM NO3-N | PPM P | PPM K-M | PPM CA | PPM MG | PPM NA | %N |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 52.1 | 21.0 | 26.7 | 19.30 | 1.65 | 144 | 189 | 778 | 640 | .043 |
| 2 | 44.5 | 15.0 | 20.4 | 12.60 | 2.11 | 134 | 524 | 355 | 322 | .055 |
| 3 | 64.4 | 16.9 | 18.5 | 21.00 | 1.65 | 64 | 565 | 563 | 412 | .043 |
| 4 | 53.4 | 21.0 | 25.5 | 1.64 | 1.65 | 188 | 453 | 678 | 650 | .068 |
| 5 | 51.9 | 21.2 | 26.8 | 5.09 | 1.65 | 243 | 440 | 860 | 683 | .065 |
| 6 | 51.5 | 20.4 | 27.9 | 2.46 | 1.65 | 390 | 463 | 1994 | 1114 | .054 |
| 7 | 52.0 | 21.2 | 26.7 | 2.18 | 2.58 | 499 | 291 | 1302 | 593 | .100 |
| 8 | 50.0 | 20.2 | 29.7 | 7.35 | 3.04 | 684 | 514 | 1236 | 796 | .046 |
| 9 | 56.2 | 18.1 | 25.6 | 9.47 | 1.20 | 102 | 565 | 659 | 1257 | .068 |
| 10 | 59.2 | 17.2 | 23.4 | 7.35 | 1.20 | 86 | 442 | 835 | 823 | .016 |
| 11 | 54.1 | 19.1 | 26.7 | 10.20 | 2.11 | 227 | 276 | 876 | 1162 | .038 |
| 12 | 43.4 | 24.4 | 32.0 | 1.11 | 4.48 | 252 | 1049 | 1785 | 5435 | .142 |
| 13 | 45.0 | 24.4 | 30.4 | 0.33 | 3.04 | 169 | 302 | 348 | 1397 | .141 |
| 14 | 41.4 | 26.5 | 32.0 | 1.11 | 2.58 | 198 | 230 | 273 | 1208 | .106 |
| 15 | 45.8 | 25.2 | 28.9 | 2.46 | 1.65 | 195 | 286 | 692 | 870 | .034 |
| 16 | 47.5 | 23.2 | 29.1 | 2.74 | 1.20 | 163 | 688 | 1118 | 6766 | .071 |
| 17 | 56.2 | 20.6 | 23.0 | 2.46 | 1.65 | 121 | 358 | 368 | 1728 | .063 |
| 18 | 62.3 | 17.6 | 20.0 | 4.18 | 12.40 | 140 | 686 | 581 | 1543 | .056 |
| 19 | 45.1 | 25.6 | 29.1 | 9.47 | 14.20 | 326 | 783 | 768 | 3333 | .086 |
| 20 | 37.2 | 30.6 | 32.1 | 19.30 | 0.76 | 192 | 494 | 875 | 1006 | .059 |
| 21 | 64.5 | 17.9 | 17.4 | 3.88 | 1.65 | 320 | 366 | 340 | 1413 | .059 |
| 22 | 54.0 | 17.1 | 28.8 | 1.37 | 3.99 | 163 | 688 | 1118 | 6766 | .077 |
| 23 | 36.1 | 27.1 | 36.7 | 4.46 | 1.20 | 74 | 67 | 537 | 427 | .025 |
| 24 | 50.1 | 21.1 | 28.7 | 11.30 | 2.58 | 262 | 332 | 291 | 399 | .146 |
| 25 | 47.8 | 24.4 | 28.0 | 3.30 | 1.65 | 182 | 122 | 337 | 394 | .025 |
| 26 | 42.2 | 28.0 | 29.7 | — | — | — | 146 | 140 | 138 | — |
| 26 | 44.9 | 29.3 | 25.7 | — | — | — | 304 | 417 | 401 | — |
| 27 | 35.9 | 33.5 | 30.5 | — | — | — | 90 | 54 | 46 | — |
| 28 | 26.9 | 40.7 | 32.3 | — | — | — | 484 | 465 | 250 | — |
| 28 | 26.6 | 44.3 | 29.3 | — | — | — | 495 | 501 | 289 | — |
| 29 | 26.8 | 45.3 | 27.8 | — | — | — | 67 | 28 | 16 | — |
| 29 | 7.3 | 45.3 | 47.3 | — | — | — | 47 | 44 | 15 | — |
| 30 | 40.2 | 30.3 | 29.3 | — | — | — | 205 | 942 | 975 | — |
| 30 | 34.0 | 34.2 | 31.7 | — | — | — | 329 | 1187 | 1108 | — |
| 30 | 32.8 | 34.3 | 32.7 | — | — | — | 377 | 1310 | 901 | — |
| 30 | 44.2 | 34.3 | 21.3 | — | — | — | 380 | 1433 | 688 | — |
| 30 | 35.2 | 32.3 | 32.3 | — | — | — | 371 | 1269 | 650 | — |
| 31 | 28.5 | 34.7 | 36.7 | — | — | — | 66 | 266 | 279 | — |
| 31 | 39.5 | 33.7 | 26.7 | — | — | — | 83 | 394 | 271 | — |
| 31 | 31.2 | 36.5 | 32.2 | — | — | — | 67 | 860 | 304 | — |
| 31 | 28.5 | 38.7 | 32.7 | — | — | — | 74 | 1105 | 335 | — |
| 31 | 67.2 | 20.5 | 12.2 | — | — | — | 334 | 1228 | 263 | — |
| 32 | 20.0 | 37.0 | 43.0 | — | — | — | 204 | 427 | 427 | — |
| 32 | 50.0 | 25.0 | 25.0 | — | — | — | 832 | 345 | 371 | — |
| 32 | 50.0 | 26.0 | 24.0 | — | — | — | 824 | 353 | 373 | — |

Page 4
Soil Analyses (1981 - 1987)
Trail Mountain #9 Mine

| NO. | %SAND | %CLAY | %SILT | PPM NO3-N | PPM P | PPM K-M | PPM CA | PPM MG | PPM NA | %N |
|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 42.0 | 28.0 | 30.0 | -- | -- | -- | 354 | 245 | 261 | -- |
| 32 | 54.0 | 26.3 | 19.6 | -- | -- | -- | 466 | 624 | 345 | -- |
| 32 | 50.0 | 28.3 | 21.6 | -- | -- | -- | 452 | 386 | 458 | -- |
| 33 | 42.0 | 28.0 | 30.0 | -- | -- | -- | 701 | 724 | 453 | -- |
| 33 | 44.0 | 30.0 | 26.0 | -- | -- | -- | 663 | 642 | 522 | -- |
| 33 | 36.0 | 32.1 | 31.8 | -- | -- | -- | 563 | 563 | 448 | -- |
| 33 | 36.0 | 31.0 | 33.0 | -- | -- | -- | 706 | 547 | 353 | -- |
| 33 | 46.0 | 28.3 | 25.6 | -- | -- | -- | 796 | 637 | 1233 | -- |
| 34 | 40.0 | 29.3 | 30.6 | 3.02 | 0.76 | 54 | 394 | 348 | 611 | -- |
| 34 | 42.0 | 27.1 | 30.8 | 3.59 | 1.20 | 73 | 408 | 445 | 913 | -- |
| 34 | 42.9 | 27.7 | 29.3 | 3.59 | 1.65 | 78 | 374 | 552 | 1387 | -- |
| 34 | 42.9 | 25.7 | 31.3 | 5.09 | 1.65 | 103 | 420 | 445 | 662 | .017 |
| 34 | 45.2 | 25.7 | 29.0 | 5.72 | 1.20 | 99 | 381 | 535 | 1093 | .022 |
| 35 | 45.2 | 26.6 | 28.1 | 6.03 | 1.65 | 74 | 374 | 537 | 1287 | .031 |
| 35 | 38.9 | 30.7 | 30.3 | 3.88 | 3.04 | 84 | 365 | 537 | 1272 | .021 |
| 35 | 43.2 | 25.5 | 31.1 | 7.02 | 2.11 | 76 | 362 | 558 | 1198 | .029 |
| 35 | 46.5 | 24.7 | 28.7 | 3.88 | 3.04 | 50 | 458 | 366 | 729 | .041 |
| 35 | 49.2 | 25.7 | 25.0 | 11.70 | 3.04 | 27 | 281 | 120 | 72 | .029 |
| 36 | 40.2 | 21.0 | 38.8 | -- | 0.90 | 95 | -- | -- | -- | -- |
| 36 | 17.0 | 21.6 | 61.4 | -- | 0.90 | 63 | -- | -- | -- | -- |
| 36 | 10.8 | 37.4 | 51.8 | -- | 0.60 | 80 | -- | -- | -- | -- |
| 36 | 12.0 | 30.4 | 57.6 | -- | 0.40 | 53 | -- | -- | -- | -- |
| 36 | 14.2 | 29.0 | 56.8 | -- | 0.60 | 75 | -- | -- | -- | -- |
| 37 | 47.8 | 18.6 | 33.6 | -- | 2.30 | 372 | -- | -- | -- | -- |
| 37 | 68.6 | 12.8 | 18.6 | -- | 1.00 | 280 | -- | -- | -- | -- |
| 37 | 51.4 | 16.6 | 32.0 | -- | 2.40 | 340 | -- | -- | -- | -- |
| 37 | 77.0 | 10.0 | 13.0 | -- | 1.00 | 152 | -- | -- | -- | -- |
| 37 | 43.4 | 18.2 | 38.4 | -- | 2.50 | 293 | -- | -- | -- | -- |
| 37 | 38.8 | 23.0 | 38.2 | -- | 2.50 | 196 | -- | -- | -- | -- |
| 37 | 65.2 | 15.0 | 19.8 | -- | 1.20 | 38 | -- | -- | -- | -- |
| 37 | 49.4 | 20.4 | 30.2 | -- | 3.20 | 65 | -- | -- | -- | -- |
| 38 | 37.3 | 25.3 | 37.4 | 1.99 | 47.20 | 160 | 147 | 115 | 42 | .110 |
| 39 | 32.6 | 27.3 | 40.2 | -- | -- | -- | 146 | 238 | 251 | -- |
| 40 | 38.0 | 27.3 | 34.7 | 2.83 | 18.68 | 147 | 116 | 85 | 35 | .110 |
| 41 | 34.6 | 26.0 | 39.4 | -- | -- | -- | 174 | 207 | 143 | -- |
| 42 | 39.3 | 25.3 | 35.4 | 1.23 | 14.63 | 144 | 107 | 97 | 71 | .110 |
| 43 | 48.6 | 20.0 | 31.4 | -- | -- | -- | 112 | 79 | 146 | -- |
| 44 | 38.6 | 26.0 | 35.4 | 0.69 | 141.78 | 131 | 124 | 110 | 44 | .070 |
| 45 | 32.6 | 28.0 | 39.4 | -- | -- | -- | 114 | 225 | 366 | -- |
| 46 | 43.3 | 25.3 | 31.4 | 1.44 | 17.47 | 112 | 95 | 69 | 52 | .110 |
| 47 | 38.6 | 26.0 | 35.4 | -- | -- | -- | 71 | 72 | 90 | -- |
| 48 | 36.6 | 28.0 | 35.4 | 2.27 | 308.07 | 195 | 146 | 112 | 41 | .100 |
| 49 | 36.0 | 27.3 | 36.7 | -- | -- | -- | 150 | 302 | 428 | -- |
| 50 | 34.7 | 26.6 | 38.7 | -- | -- | -- | 141 | 253 | 232 | -- |
| 51 | 34.0 | 29.3 | 36.7 | -- | -- | -- | 92 | 133 | 400 | -- |
| 52 | 38.0 | 25.3 | 36.7 | -- | -- | -- | 112 | 205 | 176 | -- |
| 53 | 22.7 | 34.6 | 42.7 | -- | -- | -- | 448 | 614 | 528 | -- |

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# BIOLOGY

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Yellow highlight signifies Text/Information Previously in Approved DOGM Permit, Moved and incorporated into Chapter 3 from previous Chapters 9 & 10). Red text within the yellow highlight is revised text. The un-highlighted text is new information being added to the permit document.

# CHAPTER 3
# Biology

## 310 Introduction

This section contains the description of the vegetative, fish and wildlife resources of the permit and adjacent areas. The vegetative productivity of the mine area was not measured in 1948 when mining began. Because the on-site streams are either ephemeral or intermittent, fish are not likely to be present within the permit area. Appendix 3-10-7 contains a macroinvertebrate study on Cottonwood Creek. The author of the study concluded that the impact of the mining operation on the Cottonwood Creek invertebrate community is negligible as determined by the prescribed sampling program. Because of various confounding factors unanticipated in the original design the study more direct conclusion is not possible. The wildlife species of concern are elk and mule deer. Fossil Rock has leased the Cottonwood Tract. Although this tract/lease will not be mined until permitted, associated information is included in this chapter.

### 311 Vegetative, Fish and Wildlife Resources

Vegetative, fish and wildlife resource conditions in and adjacent to the Mine are discussed in Section 320, Appendix 3-10-1, 3-10-2 and 3-10-8L.

### 312 Potential Impact to Vegetative, Fish and Wildlife Resources

Potential impact to vegetative, fish and wildlife resources and the associated mitigation plan are presented in Sections 330 and 340 of this application.

### 313 Description of Reclamation Plan

The reclamation plan used to restore the vegetative, fish and wildlife resources to a condition suitable for the postmining land use is presented in Section 340.

## 320 Environmental Description

### 321 Vegetation Information

This section contains the environmental descriptions for the vegetation for the permit and adjacent areas. Vegetation communities are shown on Plate 3-1.

#### 321.100 Vegetation Communities

**Disturbed Area:** A preliminary survey of the mine plan area indicated that four plant community types were in the boundaries of the area which had been disturbed or might be disturbed by further expansion of the mine facilities. Sites for concentrated sampling were chosen. The following methods were utilized.

**Methods**

Trees - The point-quarter method was used to determine tree density and frequency. Ten points along a 500 foot transect were used. The four nearest trees to each point (one in each of four quadrants) were measured for diameter and distance from the point. Four saplings were also measured for distance but not diameter at each point. Thus 40 trees and 40 saplings were measured in each of the four plant communities. Pinion and juniper trees were measured at one-foot height for diameter, and all other trees were measured at breast height (diameter-breast-height = DBH). These tree measurements yielded tree and sapling density and frequency. Tree dominance in terms of basal area was obtained from DBH. Sapling data provided estimates of tree reproduction. Tree (canopy) cover was estimated by the line-intersect method along a 500-foot transect with in-out measurements having a 6-inch resolution.

Understory Vegetation - Cover, density, and frequency of understory plants plus non-living cover

of litter, rock, and soil were measured by the quadrate method. The one-meter-square quadratus were spaced every ten feet along the selected transects. The Riparian and Conifer Communities were sampled with 30 quadratus each, the Grassland-Shrub Community was sampled with 50 quadratus, and the Pinion-Juniper Community was sampled with 50 quadratus, and the Pinion-Juniper Community was sampled with 5l quadratus. Living plants were determined to species and their percent of total area in each quadrate (cover) was estimated. The number of separate plants was also counted (density). These data were grouped by growth form into trees; shrubs and vines; grasses, sedges, and rushes; forbs; and cryptograms.

Reference Areas - Two vegetation communities were assigned reference areas. One is in the Riparian Community, and one is in the Grassland Shrub Community. These have been permanently marked, and are shown on Map A, Appendix 3-9-1. The riparian reference area represents the pre-disturbance condition of the parking area, coal loading facilities, and mine buildings area. The grassland-shrub reference area represents the pre-mining grassland-shrub community--part of which still exists above the mine. Both reference areas were sampled quantitatively. Data are included in Vegetation Resources, of this Chapter.

**Sampling Adequacy**

The data summarized for each sampled plant community was subjected to precision analysis using the statistic:

$$N = \left( \frac{ts}{px} \right)^2$$

in which:

N = number of points, trees, quadrats, etc. which are necessary to sample within certain prescribed precision and confidence limits.

t = student's t-value for two-tailed tests and N-1 degrees of freedom. Various confidence limits were tested, but the minimum acceptable level was 80%.

s = standard deviation

0 = the mean or average of a group of values

p = sampling precision, entered as a decimal but representing the percent variability around the true

population mean.

In this test, N, the number of samples required to adequately sample the population at 80% confidence, and p = +/-20% was calculated for each parameter (DBH, tree distance (density), sapling density, total plant cover, non-living cover, etc.). Precision was also calculated for these data using the actual number of samples used. This was done for 95%, 90%, and 80% confidence limits.

The interpretation of these precision tests is given in the following example. If N is calculated using the results of 30 samples, the 30 measurements are summed to obtain the mean (x) and standard deviation (s). The proper value of t is obtained from a t-table for N-l = 29 degrees of freedom under the desired confidence limit column (95%, 90%, 80%, etc.). The value of p is also selected; assume p = +/-.20 (which means the true population is to be estimated within +/-20% precision). Assuming the example yielded an answer of N = 26, we could say that the 30 actual measurements constituted an adequate sample since only 26 were required to meet the criteria of +/-20% with 80% confidence level. If we then said that x was the mean for the population, we would be within +/- 20% of the true mean in 80 out of l00 times that we sampled the population in the same way.

The true precision for our 30 samples could also be calculated by using

$$p = \frac{ts}{Nx} \qquad (9\text{-}2)$$

In the above example it would be less than +/-0.20 (+/-20% precision) because only 26 samples were needed to obtain p = +/- 0.20; in fact, it would be p = +/- 0.18 and the true precision is +/-18% with 80% confidence.

Vegetation sampling is done within various confidence limits to suit different requirements. Higher values require more samples and increase costs. The value of 80% is accepted by the U.S. Bureau of Land Management for estimating vegetation, productivity, etc. Likewise, p = (+/-20% precision) is normally accepted in vegetation sampling work.

Grassland-Shrub and Conifer communities on top of Trail Mountain are quite similar to those sampled below and are not expected to undergo perturbation from mining activities. The four

sampled communities will be discussed in order of elevational scale; i.e. Riparian (streamside) in the bottom of the canyon, Pinion-Juniper above the Riparian, Grassland-Shrub above the mine mouth, and the Conifer Community directly west of the mine mouth and contiguous with the Grassland-Shrub Community. Discussions of these community types will be followed by a short treatment of the results of mapping, threatened and endangered species, and sampling adequacy.

*Riparian (Streamside) Plant Community/General Description*

The Riparian Community was sampled just north of the Mine offices in Cottonwood Canyon beginning about 200 feet upstream from the office building. A 500 foot transect was run from that point along the west side of the stream to avoid the disturbances caused by the canyon road on the east side of the stream. Steep banks on each side of the stream are 10 to 30 feet high with slopes ranging from 40% to 90% where the stream has cut through old stream bed material. Vegetation is comparatively dense with a heavy understory of grasses, forbs, and scattered shrubs. Some 86 plant species were encountered in a survey of the stand. These are listed in Table 3-4 by life form (trees, shrubs, grasses, forbs) with scientific and common names. The greatest species diversity occurred among the forbs, which have 48 species. Shrubs and vines were represented by 19 species, grasses and sedges by 10, and trees by 9. Narrow leaf cottonwood (Populous angustifolia) dominates the canopy layer and is reproducing vigorously with many seedlings and saplings appearing also in the understory. The total canopy cover measured on the line intercept was 40%, leaving 60% open space in this area next to the stream.

*Riparian Tree Data*

Table 3-5 summarizes the data taken by the point quarter method for 10 points along a 500 foot transect. A total of 40 trees and 40 additional saplings were measured. Three tree species came into the sample plus one large chokecherry (Prunus viginiana) reached tree size (DBH of 4 inches or more) in this case in the fourth quadrant of point 10. Tree density estimated from the sample was 87.8 trees per acre with 97.5% of these being narrowleaf cottonwood. Narrowleaf cottonwood dominated in all parameters of density, basal area, cover, and frequency with an importance value (IV) of 397.7 out of a possible 400 IV points for trees. Basal area and percent cover were not measured for seedlings and saplings, but narrowleaf cottonwood dominated the understory also with an importance value of 178.3 out of a possible 200 points for 89.2% of relative IV. The C x F

index (cover x frequency), another measure of relative importance, also shows similar traits for the trees. Saplings of three species occurred in this community at a density of 892 per acre. Since fully grown trees occur at 88 per acre, it appears there is a natural mortality rate of about 90% among established tree seedlings in this community.

*Riparian Understory Data*

Table 3-6 summarizes the streamside species sampled in the understory with 30 one-meter square quadrats. Forbs proved to be the most important life form followed by grasses, as may be seen by the importance values and the C x F index at the right of Table 3-6. Out of a possible 300 IV points, forbs had 142.3 (47.4%) to 111.8 (37.3%) for grasses; and of a possible total of 10,000 C x F index points, forbs had 606.6 compared to 261 for grasses. Counts of the stems for each species show that grasses have higher density counts with about twice the number of stems as forbs (66.7% density for grasses and 31.5% for forbs). The most important species can be picked out by the IV values listed in Table 3-6. Poa pratensis (Kentucky bluegrass) had the highest individual IV value (80). This was followed by 47 for (Aster chilensis) 43.4 for scouring rush (Equisetum ervense), 38 for orchard grass (Doctylis glomerata), 16.4 for narrow leaf cottonwood seedlings, 15.2 for dandelion (Taraxacun afficionale)(, and 11.7 for western virgin's bower (Clematis ligusticifolia). The C x F index, however, shows that (Aster Chilensis) (CxF = 312.4 and scouring rush (C x F = 266.4) are very important compared to C x F = 176.8 for Kentucky bluegrass. This is based mainly on the high cover values measured for (Aster) and for scouring rush, as well as a high frequency of occurrence in the quadrats.

The overall average living understory cover was measured at 35.5% of total cover, and it ranged from 0.6% to 67% with litter contributing about 51% of non-living cover. Rock and exposed soil were of rather minor importance (2.6% and 8.6% of total cover respectively

*Pinion-Juniper Plant Community/General Description*

This stand is located just north of the Mine office on steep south- and east-facing slopes above the Riparian Community reference area. The measured transect was 500 feet long, running in a south-north direction along a $168^0$ bearing line (magnetic). The slope in the sampling area is about 42% with an exposure of 78+/- EEN. Large boulders are scattered among the trees, which causes a variety of relief and abrupt changes in percent slope.

There are 62 plant species in this community, as listed in Table 3-7. The dominant tree is pinion pine (Pinus edulis). Significant percentages of Rocky Mountain juniper (Juniperus acopulorum), limber pine (Pinus flexilis), and Douglas fir (Pseudotsuga menziesii) also occur. The greatest species diversity occurs among the forbs (36 species) followed by shrubs (13 species), grasses (7 species), and trees (6 species).

*Pinion-Juniper Tree Data*

Table 3-8 summarizes the data for four species of trees occurring in the point quarter and line intercept sampling data. Density of trees was estimated from tree distance at 99.2 trees per acre. Seedlings and saplings are present at 133.9 trees per acre. The combined total for both trees and young trees is 233.1l trees per acre. Since full size trees represent about 43% of the combined total, a natural mortality rate of about 57% is suggested for tree seedlings in this community. Pinion pine showed the greatest values for density, basal area (dominance), cover, and frequency. The importance value (IV) of 239.6 for pinion pine far exceeds the other trees, as does the C x F value of 2,380.5. Rocky Mountain juniper is the next most important tree species with an IV of 70.8 and C x F index of 447. These dominant species are followed by Douglas fir with an IV score of 59.3 and a C x F value of 240.

Tree reproduction indicates that seedlings and saplings of pinion juniper still dominate at an IV of 85.6 out of a possible 200; but Douglas fir, with an IV of 56.1, is more important than juniper at 43.8. Perhaps Douglas fir is increasing in this community. When both trees and reproduction are considered together, the density values show that Douglas fir is slightly more important than juniper and may indicate trends in successional directions, as do the importance values cited above.

*Pinion-Juniper Understory Data*

The data on understory vegetation for the Pinion-Juniper Community are summarized in Table 3-9. Grass species dominate the understory vegetation with a life form total importance value of l57.4 or 52.5% importance. Slender wheatgrass (Agropyron trachycaulum) was the most important species in the understory, with an importance value of 132.4 or 44.1% importance in comparison to the other understory species. On the basis of cover and frequency, this translates to a C x F index of 1067.7 and a total C x F

index of 1067.7 and a total C x F index for grasses of 1104.6.

Lichens are the next most abundant life form in terms of cover and frequency (but not biomass or forage value), with an importance value of 30.4. This is followed by Utah serviceberry (*Amelanchier utahensis*) at 24.5. Hood's phlox (Phlox hoodii) at 17.5, and Sandberg's bluegrass (Poa secunda) at 15.3.

Generally, the understory vegetation is rather sparse in density except for patches of slender wheatgrass. The average cover value for living plants was 23.4% and ranged from 7.5% where mostly rock was exposed in the quadrat to 85% under bushes of Utah serviceberry. This leaves non-living cover averaging approximately 75% and consisting of rock (27.3% cover), litter (26%), and soil (22.6%).

*Grassland-Shrub Community Data/General Description*

This stand is located immediately above the Mine mouth and loading areas on the steep, generally east-facing mountain slope. The stand runs around the brow of the hill and has exposures ranging from north-northeast to east. The soils are rather heavy, being silty clay to loamy silty clay soils dotted with many boulders and rocks caused by talus from the rocky cliffs above. The slopes range from 43% to about 48%, measured by inclinometer.

The vegetation forms are mainly grasses with scattered shrubs and an occasional tree here and there, especially at the west end of the sampled stand.

Table 3-10 lists plant species observed in this plant community. A total of 37 species are recorded, consisting of 3 trees, 11 shrubs, 6 grass and sedge species, and 17 forb species. Of the forbs, only one annual was observed (Lappula aredowskii). No extensive tree canopy exists except for the isolated trees, so no tree data was taken in this community.

*Grassland-Shrub Understory Data*

The summary data listed in Table 3-11 provide estimates from the vegetative sampling of cover, frequency, and density for two sites. Grasses and sedges were the most abundant as is indicated by the importance value (IV) and the C x F index on the right side of Table

3-11. The IV value is obtained by adding up the relative percentages of cover, frequency and density. The C x F index is obtained by multiplying the cover and frequency together. Thus, it is possible to obtain a total C x F value of 10,000. The higher the IV or the C x F index, the more abundant and, consequently, the more important is the plant species or life form listed.

Based on these indices, grasses had an IV of about 146 out of a possible 300, or 53% importance. Slender wheatgrass, like the pinion-juniper stand discussed above, had the highest IP value (IP = 131 plus C x F = 1383.3). Slender wheatgrass was followed in importance by a forb called shrubby bedstraw (Galium multiflorum) at an IV of about 32, and the shrub called shadscale (Atriplex confertifolia) at an IV of about 20. Other species of somewhat less importance were sticky rabbitbrush (Chrysothamnus visidiflarus), snakeweed (Gutierrezia sarathrae), Sandberg's bluegrass (Poa secunda), Hood's phlox (phlos hoodii), and buckwheat (Eriogonum carymboxum).

Total cover (54.4%) was rather high due to the heavy grass cover (33.4%). Because of this high cover, there was less soil and rock exposed without living cover or litter above it.

*Conifer Plant Community/General Description*

This plant community is located west of the mine mouth on north-facing slopes of a rather large draw trending east and west up Trail Mountain's east slopes. The slopes range from 50 to 60% with an exposure to the north. The sampling transect extended along a line bearing $260^0$ west. The forest-covered steep slopes are at the base of steep cliffs which have contributed talus to the forest soil below. The soil is very rocky as with the contiguous Grassland-Shrub Community further east already described. The understory vegetation is sparse. A species list with a total of 43 species was compiled and appears in Table 3-12. Six trees, 9 shrubs, 6 grasses and sedges, and 22 forbs were found in the stand, of which some 26 species came into the sample transect.

*Conifer Tree Data*

Table 3-13 summarizes the tree data for the conifer stand. It shows white fir and Douglas fir to be co-dominant, with an IV value of 169 for white and 162 for Douglas fir. These accounted for almost 83% of the tree dominance and almost all of the total C x F index, as

can be seen on the right side of Table 3-13. Douglas fir had the greatest amount of basal area, but white fir contributed the greater amount of canopy cover and was 10% more frequent.

Total density of trees was about 74 per acre, and Douglas fir and white fir were even although Douglas fir had almost twice as many seedlings and saplings. Both trees are reproducing themselves so this stand can be considered a climax community for this exposure, elevation and other static factors of soil, etc. Mountain red juniper showed good reproduction, but there were few tree-size individuals in the samples.

*Conifer Understory*

As in the Grasslands-Shrub Community immediately east of this stand, grass was the most important species in the understory (see Table 3-14). Forbs were next in importance. Here again slender wheatgrass proved to be most ubiquitous, with an IV value of 106 and a C x F index of 446. The most important forbs were shrubby bedstraw (Galium multiflorum) and Hood's phlox at scores of 28 and 27 on the IV index respectively. The two shrubs of most importance were creeping barberry (Mahonia repens) and Utah serviceberry at IV scores of 15 and 14 respectively. The grass blue wildrye (Elymus glauca) and the sedge (Carex geyeri) were also of minor importance at IV 231 and IV 15, in that order. Density count was the factor that provided much of the dominance for the grasses, however, with 833 stems counted in 30 quadrats.

As was mentioned earlier, the understory cover was described as rather sparse. This observation is supported by the measured low total cover value of about 23%. Litter was abundant at 23%, but soil had about 34% of absolute cover exposure under the trees. With a tree canopy of 60.4% it is understandable that understory cover is meager. This, coupled with comparatively low precipitation in this area, influences the lower understory values.

In the present study several methods were used to obtain estimates of vegetation growth in the vicinity of the mine. These methods involved sampling and using the results to estimate the population values. Adequate sampling ensures that the population parameter will be estimated with acceptable precision. Any degree of precision can be obtained by increasing the sample

size. Perfection can be achieved by measuring every member of the population. This is, of course, impractical and a compromise is always struck between the level of precision and the expense and time.

**Sampling Adequacy**

The sampling adequacy and actual precision obtained for the various data obtained in the present study are summarized in Table 3-17. The minimum criterion for adequate sampling in these data is +/- 20% precision at the 80% statistical confidence level. This means that the true population mean has been estimated to within +/- 20% or better, and that if we say this is true we would be wrong only twenty times in a hundred from random causes alone.

Table 3-17 shows that in many cases the actual precision obtained in this study is much better than +/- 20%. These values are shown in Part B of the table where 29 of the 36 precision tests meet or exceed the +/- 20% precision standard. Three of the seven inadequate samples are very close to the acceptance level and the remaining four involve two density estimates of understory grasses and two estimates of tree canopy (% cover). The difficulty of counting grass stems is obvious and accounts for the one problem. The tree canopy estimates, which could benefit from additional sampling, are poorest in the two plant communities least likely to be disturbed by mining activities, the Conifer and Pinion-Juniper Communities. We believe no essential conclusions or recommendations advanced in this vegetation report would be changed by additional sampling in these areas.

Seven vegetation communities and/or associations were identified in the surveyed adjacent area. None of these communities are particularly important, unique, or inordinately valuable with regard to area resources with the exception of the Riparian Areas. In fact, the non-riparian communities represent some of the most common vegetation types in the Central Utah mountains.

Seven segregate upland vegetation communities/associations were identified as: 1) Aspen Woodland, 2) Mixed Conifer Woodland, 3) Mountain Brush, 4) Pinyon-Juniper Wood-land, 5) Forb Meadow, 6) Sagebrush/Grassland, and 7) Riparian Areas (including seep and spring wetlands). One additional land type was identified (Barren) but does not comprise a vegetation community (although it does comprise a habitat type).

*Aspen Woodland.* This community is found at upper elevations typical of the montane zone (8,000 - 10,000 feet). It is largely located in the northern and central portions of the area along most slopes, aspects, and topographic positions. The Aspen type often intergrades with the Sagebrush/Grassland and Mixed Conifer communities. Three subtypes of the Aspen community occur: 1) aspen/snowberry, 2) aspen/mountain big sagebrush, and 3) aspen/creeping barberry. Quaking aspen (*Populus tremuloides*) dominates the physiognomic character of the community. Other species present in the understory include: serviceberry (*Amelanchier utahensis*), Oregon grape (*Mahonia repens*), chokecherry (*Prunus virginiana*), Rocky Mountain maple (*Acer grandidentatum*), mountain lover (*Pachistima myrsinites*), snowberry (*Symphoricarpos oreophilus*), bluebunch wheatgrass (*Agropyron spicatum*), mountain brome (*Bromus carinatus*), and Kentucky bluegrass (*Poa pratensis*) (Forest Service, 1998).

*Mixed Conifer Woodland*. This community is found at the uppermost elevations of 8,000 to 10,000 feet (montane zone). It is located throughout the area along most slopes and topographic positions, and generally northerly aspects. The Mixed Conifer type often inter-grades with the Sagebrush/ Grassland and Aspen communities. Five subtypes of the Mixed Conifer community occur within the area: 1) Douglas fir, 2) white fir, 3) Englemann spruce, 4) subalpine fir, and 5) ponderosa pine. Douglas fir (*Pseudotsuga menziesii*) usually dominates with white fir (*Abies concolor*) and blue spruce (*Picea pungens*) and is limited to more mesic sites and along watercourses. Englemann spruce (*Picea englemannii*) may codominate with Douglas fir. Subalpine fir (*Abies lasiocarpa*) can be found at higher elevations while ponderosa pine (*Pinus ponderosa*) is usually found lower in the montane zone. Given the often dense overstories, the understory is usually sparser and generally consists of the same species indicated above for the Aspen community. (Forest Service, 1998).

*Mountain Brush*. This community is found at mid-elevations, along valley walls primarily in the northeast and southwest portions of the adjacent area. The Mountain Brush type often intergrades with the Mixed Conifer community. Four subtypes of the Mountain Brush community are: 1) serviceberry, 2) oakbrush, 3) Mountain mahogany, and 4) high mountain brush. This community is variably dominated by these subtypes depending on elevation and aspect. The drier south- and west-facing slopes typically support dense stands of Gambel oak (*Quercus gambellii*), the moderate sites support Mountain mahogany (*Cercocarpus montanus* or *Cercocarpus ledifolius*), while the more mesic sites support serviceberry, bitterbrush (*Purshia*

*tridentata*), and snowberry. Understory grasses typically consist of bluebunch wheatgrass, Salina wildrye (*Elymus salinus*), and prairie junegrass (*Koeleria cristata*) (Forest Service, 1998).

*Pinyon-Juniper Woodland*. This community is found at lower to mid-elevations along most slopes, aspects, and topographic positions. The Pinyon-Juniper (PJ) type often intergrades with the Sagebrush/Grassland and Mountain Brush communities. Three subtypes of the Pinyon-Juniper community occur within the area: 1) PJ with mixed mountain brush, 2) PJ with mountain mahogany, and 3) Rocky Mountain juniper/mountain brush. This community is variably dominated by these subtypes depending on moisture and soil rockiness (the community is generally found on skeletal/ rocky soils). The first two subtypes are dominated by pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) with a significant contribution from Rocky Mountain juniper (*Juniperus scopulorum*). The third subtype is dominated by Rocky Mountain juniper. The typically sparse understory (poor to fair range condition) includes species such as mountain big sagebrush (*Artemisia tridentata* var. *vaseyana*), mountain mahogany, snow-berry, slender wheatgrass (*Agropyron trachycaulum*), Salina wildrye, prairie junegrass, and Indian ricegrass (*Oryzopsis hymenoides*) (Forest Service, 1998).

*Forb Meadow*. This community is found at two small locations in the northern portion of the area (Plate 3-1). The Forb meadow primarily intergrades with the Sagebrush/Grassland and Mountain Brush communities. This community is dominated by a single species, one flowered helianthella (*Helianthella uniflora*).

*Sagebrush/Grassland*. This community is found at all elevations and on all slopes, aspects, and topographic positions. The Sagebrush/ Grassland type intergrades with the other communities. Four subtypes of the Sagebrush/Grassland community occur within the area: 1) Mountain big sagebrush, 2) black sagebrush, 3) Salina wildrye, and 4) seeded grasslands. This community is variably dominated by these subtypes depending on moisture, soil depth and texture, and past land management. Mountain big sagebrush subtype is dominant and found throughout the area. The black sagebrush (*Artemisia nova*) is typically found on higher elevation ridges and similar topographic positions. The Salina wildrye subtype is found on areas which have historically been subjected to occasional wildfires and are in good or better range condition. In the moist bottoms, Basin big sagebrush (*Artemisia tridentata* var. *tridentata*) may dominate. Salina wildrye

may codominate in many areas and western wheatgrass (*Agropyron smithii*) is common (Forest Service, 1998).

*Riparian Areas*. This community is located along intermittent stream courses and in association with larger springs and seeps where a ready supply of water is available for at least a significant proportion of the growing season. As a result of these circumstances, riparian areas are disproportionately valuable as habitat for wildlife or watering sources for livestock. Three main subtypes of riparian areas can occur: 1) sedge wet meadows, 2) birch and willow streamsides, and 3) mesic graminoid seeps and springs. The first and third of these subtypes can occur along streamsides but are typically found in association with springs and seeps. Given the increased water availability and cooler temperatures, riparian areas tend to exhibit unique and/or more mesic species typical of higher elevations. These assemblages of graminoids (grasses) and shrubs also tend to form dense stands of vegetation. Unique trees and shrubs include narrowleaf cottonwood (*Populus angustifolia*), redosier dogwood (*Cornus sericea*), skunkbush (*Rhus trilobata*), river birch (*Betula occidentalis*), and various willows (*Salix* spp.). Grasses from the more mesic communities (Mountain Brush, Aspen, and Mixed Conifer) may be present in Riparian Areas as well as fescues (*Festuca* spp.), muhlys (*Muhlenbergia* spp.), and a variety of sedges (*Carex* spp.) and rushes (*Juncus* spp.). (Forest Service, 1998).

*Barren*. This habitat type is typically represented by rock escarpments, rubble slopes, and similar areas in association with the steep canyon walls. Barren areas are not necessarily devoid of vegetation, however, when present, it is generally very sparse and intermittent, only occurring within niches, cracks, crevices, and similar circumstances.

A vegetation map (Plate 3-1) was created from the information in this section and in the Cottonwood Canyon EIS (Appendix 2-1).

### 321.200 Productivity of Land Before Mining

Productivity data from the two plant communities adjacent to the disturbed area are shown in Tables 3-15 (Riparian) and 3-16 (Grassland-Shrub). These two communities have been disturbed in the past operations of the Mine and are the only ones likely to receive any future disturbance. The data are shown for freshly cut or green weights and also for air dry

weights. The following discussion concerns only the air-dry weights. The Riparian community produced a total of 1,516 pounds per acre (air dry), while the Grassland-Shrub Community produced 910 lb/acre. Moisture in these productivity measurements accounted for 64 and 49 percents of the totals in the two communities so the corresponding fresh weights were 4,236 and 1,774 lb/acre of total plant productivity. Since only understory plants were measured, tree data is for seedlings and saplings only. Even so, the Riparian Community out produced the Grassland-Shrub Community by a factor of about two. The most abundant life form in both communities was grass with 36% of total productivity in the Riparian and 79% in the Grassland-Shrub Community. Forbs and shrubs were about equal in the Riparian Community at 30 and 31% (455 and 464 lb/acre) respectively. In the Grassland-Shrub Community, shrubs were the second most productive life form at 9% of the air-dry total while forbs represented only about 1%.

The Soil Conservation Service estimated productivity for the Riparian Community to be 2500 lbs/acre and the Grassland Shrub Community to be 900 -1000 lbs/acre. (See Appendix 3-9-1).

### 322 Fish and Wildlife Information

For mule deer, elk, and threatened and endangered species, regional population areas were evaluated to assess potential impacts. Wildlife species for analysis were determined through consultation with state and federal agency personnel and evaluation of pertinent information sources. A review of published sources including, Forest Service file information, Utah Division of Wildlife Resources (UDWR) files, and PacifiCorp (1997). Discussions of wildlife populations within the study area are provided below. A listing of wildlife species potentially residing within the study area as well as information on relative abundance and habitat associations is provided in PacifiCorp (1997, LBA Data Adequacy). Species are listed on Tables 3-20 through 3-26.

Although, endangered fish species were identified as having critical habitat in Emery County by the U.S. Fish and Wildlife Service they are inhabitants of large rivers and do not occur near the mine. The nearest known occurrence of these species is at the mouth of the San Rafael River and in the Green River, over 70 miles from the project area.

Big Game - Elk and mule deer are the two big game species which are economically important and are common inhabitants of the Wasatch Plateau. Elk tend to occupy the higher elevation aspen

and mixed conifer habitats from spring through early fall and move to lower elevation mixed shrub, pinyon-juniper, and sagebrush habitats for winter range, although some use of higher elevation mixed shrub habitats occurs where exposure and wind limit snow accumulations. Elk generally occupy winter range from December 1 through April 15. Elk calving typically takes place between May 15 and July 5 and occurs in areas of suitable aspen habitat. Forage available within calving habitat is especially important since elk nutritional demands for successful calving, cow recovery, and early calf growth are crucial.

Mule deer use most habitat types in spring through fall but are most abundant in shrublands in rough, broken terrain where abundant food and cover are provided. Mule deer populations within the area exhibit seasonal movement with most shifts in distribution occurring because of elevational migration in response to snow cover. Lower elevation pinyon-juniper and sagebrush habitats represent suitable winter range, and most portions of mule deer winter range are located at the periphery of National Forest lands and on adjacent private lands. Additional information in Appendix 3-10-3.

Elk and Deer Range on Plate 3-2, shows High Priority Value (UDWR) summer range for deer and elk, although the lower elevations of the eastern and southeast portions of the area exhibit High Priority Value and Critical Value (UDWR) winter range for both species. The UDWR defines Critical habitat as sensitive use areas that are limited in availability or provide unique qualities for high interest wildlife. High Priority habitat is defined as an intensive use area that, due to relatively wide distribution, do not constitute critical values but which are highly important to high interest species.

Raptors -*Data from the 1981 survey are shown on Table 3-21. Several species of raptors are known to occur and nest within the region of the study area. Potential breeders include turkey vulture, northern harrier, golden eagle, Cooper's hawk, sharp-shinned hawk, northern goshawk, red-tailed hawk, prairie falcon, peregrine falcon, American kestrel, western screech owl, flammulated owl, great horned owl, northern pygmy owl, long-eared owl, short-eared owl, and northern saw-whet owl.*

Nest site preferences of raptors potentially breeding in the area vary considerably. Red-tailed hawks, golden eagles and great horned owls typically nest in relatively large trees with open crowns or on cliff ledges and areas of rock outcrop. Great horned owls do not build their own nests and

often occupy old nests of eagles, hawks, ravens, crows, and tree squirrels in larger trees or on cliff faces. Turkey vultures' nest on cliff ledges and in hollows in snags or stumps, or in caves while prairie falcon nests on scrapes on cliff ledges or in rock cavities. These species prefer open shrublands and meadow areas for hunting. Suitable nesting habitat for these species is provided primarily by large cottonwood trees along Cottonwood Creek and Straight Canyon or by cliffs and rock escarpments along Cottonwood Creek Canyon, Straight Canyon, and the east side of Joes Valley. Nesting by golden eagle, red-tailed hawk, prairie falcon, and peregrine falcon has been documented in these areas of rock escarpment (UDWR file information and PacifiCorp, 1997). Areas of rock escarpment where nesting activity had been documented are depicted on Plate 3-4, Raptor Nesting Areas. Because of the potential sensitivity of raptor nest sites to human disturbance, specific raptor nest locations are not provided. See Appendix 3-10-4 and 3-10-6 for additional information.

The remaining potential breeding raptors in the study area are associated primarily with forested habitats except for northern harrier and short-eared owl. Northern harriers typically nest on the ground or in low shrubs in pockets of dense shrub and grass cover typically on drainage side-slopes or near wetlands. Short-eared owls are also ground nesters and prefer to nest in moist meadow or wetland habitats. Springs and creeks supporting riparian wetland vegetation represent the areas of suitable nesting habitat for this species.

Cooper's hawks' nest in aspen or in deciduous trees in riparian situations but are also known to nest in mature conifers (Ehrlich et al., 1988; Terres, 1980). Sharp-shinned hawks, unlike Cooper's, nest in a wide variety of wooded habitats ranging from mountain mahogany stands to conifers.

The American kestrel is a cavity nester, and abandoned woodpecker holes, magpie nests, and crevices in rock outcrop are used as nest sites. A variety of open and wooded habitats are occupied by the American kestrel, although it avoids densely forested habitats.

Western screech owl, northern saw-whet owl, and northern pygmy owl nest in natural tree cavities or abandoned woodpecker or squirrel holes. Western screech owls are usually found in deciduous riparian habitats, while mature and old-growth mixed deciduous and coniferous forests are considered the best habitats for breeding for northern saw-whet and northern pygmy owls since the most suitable cavities for nesting are excavated by woodpeckers in large, diseased or dead trees (Reynolds et al., 1989). Northern saw-whet owls and northern pygmy owls occur over a relatively wide elevation range and have been found in low-elevation deciduous woodlands

to high-elevation conifer forests (Reynolds et al., 1989). Northern saw-whet owls seem to prefer marshy or riparian areas within coniferous forests (Terres, 1980). Nests of northern pygmy owls are frequently next to meadow or marshy openings within deciduous woodlands and coniferous forests (Reynolds et al., 1989).

Long-eared owl, like great horned owl, do not build their own nest and usually occupy abandoned magpie, hawk, crow, or squirrel nests in tall shrubs or trees (Ehrlich et al., 1988). They inhabit coniferous and mixed coniferous/deciduous woodlands. Nest sites are often at forest edges near water or moist meadow habitats (Terres, 1980).

*Bald Eagle*. Bald eagles can often be found near lakes and reservoirs as well as upland areas on the Forest during the late fall and early winter. However, once lakes and reservoirs freeze over, most eagles will leave the area except those feeding in upland habitats may stay late into the winter. In winter, bald eagles commonly roost in large groups. These communal roosts are in forested stands that provide protection from harsh weather (Stalmaster, 1987).

A pair of nesting bald eagles has been located approximately 7 miles east of the Forest Service boundary near the town of Castle Dale. In 1994, a review of the nesting adults and fledglings indicated their foraging habits were within a 5-mile radius from the nest tree (Boschen, 1995). No bald eagles are known to nest on the Forest. Most bald eagle sightings on the District have been at Joes Valley Reservoir and Huntington Canyon. The eagles will use these areas for foraging and resting until heavy snow cover and lack of open water increases. The eagles then continue their winter migration.

Raptor surveys have been conducted on a yearly basis within the Cottonwood Canyon area, but no bald eagle use of the canyon or surrounding forested habitats has been documented. (Appendix 3-10-5 and Confidential)

*American Peregrine Falcon*. American and Arctic peregrine falcons are known to occur throughout the region primarily during spring and fall migration. The project area occurs within the nesting range of the American peregrine falcon. The peregrine's preferred nest site is a rugged, remote cliff (100 to 300 feet in height) usually overlooking water or marshy areas where prey is abundant (U.S. Fish and Wildlife Service, 1984). Preferred hunting areas include cropland, meadows, river bottoms, marshes, and lakes which attract abundant bird life. Peregrines are known to travel more than 18 miles from the nest site to hunt for food. However, a 10-mile radius around the nest is an average

hunting area (U.S. Fish and Wildlife Service, 1984). The peregrine falcon is currently expanding its range within the state of Utah and migrating, or transient peregrines have been seen on the Wasatch Plateau.

In 1996, surveys conducted by the Forest Service, Utah Division of Wildlife Resources (UDWR), and PacifiCorp discovered peregrines exhibiting nesting behavior in Cottonwood Canyon (approximately 4 miles east of Joes Valley Reservoir). The pair was observed copulating and defending a territory however, egg laying, and incubation did not occur at this site. Additional surveys (1996) conducted by Forest Service personnel found a pair of peregrines occupying a territory on the east rim of South Horn Mountain (approximately 6 miles southeast of Joes Valley Reservoir). This pair was found using the cliff systems directly below the existing electronic site. In 1996 the UDWR discovered an active peregrine nest near the Star Point Mine. The nest contained eggs, but it is not known if the nest produced young. Other known recently active nests are located on cliff areas above the east bank of Joes Valley Reservoir (Moretti, pers. comm., 1998).

*Northern Goshawk*. The northern goshawk inhabits coniferous and mixed forests in much of the northern hemisphere. Blocks of mature and old growth forest habitats (200 acres or greater) with a relatively open understory and small openings are preferred (Hayward et al., 1990). Goshawk nest sites are usually located in mature forests, near water, and on benches of relatively little slope. Nests are often used year after year. Goshawks are very protective of their young in the nest and loudly defend them to intruders. They are very sensitive to human disturbance and have abandoned nests and young due to human activities that take place too close to their nest (Kennedy and Stahlecker, 1991).

The goshawk is a resident of the Ferron-Price Ranger District, but the number of nesting birds vary year to year. Nest sites are associated with aspen and mixed conifer habitats (Forest Service file data).

*Flammulated Owl*. The flammulated owl is found in the United States and Canada only from spring through fall. This species is considered a summer resident of uncommon relative abundance, indigenous to the Wasatch Plateau (Dalton et al., 1987).

Flammulated owls prefer old growth (>200 years) or mature (>150 years) stands of ponderosa pine and ponderosa/ Douglas-fir forests, often mixed with mature aspen, as preferred nesting habitat (McCallum, 1994). A preference for stands with an open, park-like spacing of trees may be due to

this species' foraging habits (Reynolds et al., 1989). Flammulated owls are obligate cavity nesters, and they nest in natural or woodpecker cavities. Both live and dead ponderosa pine, aspen, and Douglas-fir are used for nesting (Reynolds et al., 1989). Nesting territories are relatively small; a mean size of approximately 35 acres was reported by Linkhart (1984) for a population in Colorado.

Recent surveys in southern Utah National Forests have indicated that flammulated owls are more abundant and widely distributed (Forest Service file data). Nesting by flammulated owl is likely within suitable habitat in the study areas.

*Three-toed Woodpecker*. Three-toed woodpeckers range across North America. They are found in northern coniferous and mixed forest types up to 9,000 feet in elevation. The UDWR describes the three-toed woodpecker as a yearlong resident species, of uncommon relative abundance that is indigenous to the Wasatch Plateau (Dalton et al., 1987).

Three-toed woodpeckers require mixed coniferous forest snags (standing, dead trees) for feeding, perching, nesting, and roosting, although they will feed in live trees. Foraging is typically larvae of wood-boring beetles in the bark of dead conifers (Terres, 1980). Snags at least 12 inches dbh (diameter at breast height) and 15 feet in height are required for its excavated nest cavities (Towry, 1987). Forest fires and areas of insect outbreaks may lead to local increases in woodpecker numbers after 3 to 5 years (Bull et al., 1986; Scott et al., 1980).

Forest Service surveys for three-toed woodpeckers took place in suitable habitat on the Ferron-Price, Sanpete, and Moab-Monticello Ranger Districts in June and July of 1992;1993, 1994, 1995, and 1996 field seasons on the Ferron-Price Ranger District resulted in additional three-toed woodpecker findings. This species was found on all districts surveyed (Forest Service file data).

*Townsend's Big-eared Bat*. Townsend's big-eared bat are normally found in woodlands below 9,600 feet in elevation and apparently do not prefer dense coniferous forests (Barbour and Davis, 1969). This bat is usually found in small groups (10 to 100) in mine shafts, caves, and man-made structures, often in view of light. It occurs throughout the western United States, but its distribution seems to be determined by suitable roost and hibernation sites. This bat is very sensitive to changes in temperature, and populations may be limited primarily by high winter mortality due to the absence of roosts with stable temperatures (Colorado Division of Wildlife, 1984). The Townsend's Big-eared Bat is very sensitive to human disturbance and will readily abandon roosts when disturbed

Bat surveys conducted in 1992, found Townsend's big-eared bats using inactive coal mines as hibernacula on the Ferron Ranger District. They were also found roosting in buildings on the Ferron-Price Ranger District in the town of Ferron but were not located in the mine area (Toone, 1992). Bat surveys conducted in the summer of 1997 also did not locate the Townsend's big-eared bats within the proposed mine area (Sherwin et al., 1997).

*Spotted Bat*. This bat has been found at scattered locations (primarily in arid country) in Utah and the western United States (Barbour and Davis, 1969). Habitat occupied by this bat ranges from low desert to montane coniferous forests normally below 8,000 feet in elevation (Watkins, 1977). They have been found in a variety of habitat types including open ponderosa pine, desert scrub, pinyon-juniper, and open pasture and hay fields. Cracks and crevices in limestone or sandstone cliffs provide important roosting sites (Leonard and Fenton, 1983; Easterla, 1973), especially where rocky cliffs occur in proximity to riparian areas (Findley et al., 1975).

Summer of 1997 bat surveys detected spotted bats throughout the southern and western (lower elevation) portions of the proposed mine area (Sherwin et al., 1997). The highest concentration of calls was recorded in Cottonwood Canyon and Straight Canyon. These canyons appear to represent "classic" spotted bat habitat with an abundance of fractured sandstone cliffs and large areas of suitable foraging habitat. Specific individual roost sites were not located, but general roosting areas were on cliff faces/rock outcrops in Cottonwood Canyon area (Sherwin et al., 1997). Additional roosting areas also were identified throughout the Straight Canyon drainage and portions of Cottonwood Canyon outside of the mine area.

Spotted bats were not observed foraging within Cottonwood Canyon area. It appeared that the bats were using the area primarily as roosting sites, and the canyons were used as flyways to reach lower elevation foraging areas. The principal spotted bat foraging areas were determined to be located over the lower elevation riparian habitat near the mouth of Cottonwood Canyon and along the length of Straight Canyon (Plate 3-5, Bat Habitat). Spotted bats appeared to concentrate foraging efforts above the upper canopy of riparian vegetation, especially cottonwood trees (*Populus* ssp).

Spotted bats are widely distributed in low densities throughout the entire area. These bats were detected in suitable habitat throughout the area, including using the parking lots of the Village Inn motels in Huntington and Castle Dale (Sherwin et al., 1997).

Observations made during the 1997 surveys indicated that spotted bats tolerate at least moderate human disturbance while foraging. Surveys were conducted at several sites near roads with light to moderate vehicular traffic (Crandall Canyon, Huntington Canyon, Straight Canyon), including tandem trucks used for hauling coal from the Genwal mine portal located in Crandall Canyon. Spotted bats were observed foraging at low elevation sites off the mine areas, sometimes within 30 meters of the right of way. The fact that spotted bats were relatively common in active and previously mined areas may imply that past cliff failures have not dramatically affected resident populations (Sherwin et al., 1997).

Fish. On-site streams are either ephemeral or intermittent, fish are not likely to be present. The lower section of Cottonwood Creek in Straight Canyon located about three miles from the mine site is perennial and provides the nearest fish habitat to the proposed project site. This section of Cottonwood Creek receives flows from Joes Valley Reservoir through Straight Canyon which helps maintain perennial flow. Numerous species of fish are expected to occupy perennial streams located downslope of the site. Because migratory fish barriers exist downstream, no anadromous fish inhabit the streams in Emery County. No direct effects to endangered fish are expected; however, water use associated with mining activities could cause off-site effects and modify habitats. Potential water depletions from mining operations that may have an effect on endangered fish species identified in pertinent fish recovery programs of the USFWS have been evaluated by the Windy Gap Process as it applies to existing coal mines in the Upper Colorado River Basin.

Other Species of Special Concern potentially inhabiting the permit area include Kit Fox, (Vulpes macrotis), great plains toad (Bufo cognatus), western toad (Bufo anaxyrus) and white-tailed praire dog (Cynomys leucurus).

### 322.100 Level of Detail

The scope and level of detail within this M&RP are sufficient to design the protection and enhancement plan for wildlife and fish in the area.

### 322.200 Site-specific Resource Information

This 1981 study was designed to quantitatively and qualitatively evaluate the fish and wildlife resources in habitats that might be potentially impacted by expansion and operation of the mine. Although literature review was conducted in February, March and April 1981. Efforts were made

to review pertinent unpublished theses and state and federal agency reports. Subsequent information has been gathered since that time, through various studies that are presented in the appendices

*Raptors.* The project site was initially visited in March and again in April 1981 to familiarize the researchers with specific edifice and vegetative areas. This facilitated proper determinations regarding placement of species into preferred habitats, habitat affinities and the potential impact of perturbation actions. The early visits were also necessary to check on any courtship behavior which might aid in determining the location and number of sites necessary to collect high level raptor date. Using the information obtained from the initial visits and maps, it was determined that the entire area would be traversed and observed for raptor use and activity. Since so few raptors occurred in or utilized the area of concern, considerable effort was expended to determine raptor use in adjacent areas. This was thought necessary if adequate understanding was to be given to the low level of raptor presence and use in the present and proposed mining area. Extensive field observations were made biweekly from mid-April through July. Detailed cliff searches were conducted, and the entire area of concern traversed on foot at sufficiently close intervals to flush not only raptors but the passerine types. One golden eagle in flight, at least two pair of kestrels and many passerines were observed, but raptor use was low. Nevertheless, biweekly monitoring (1980's) has occurred to determine if any raptors move into the area following fledgling in adjacent areas, or if any expand their hunting territories and fly over the area.

*Vertebrate Species*. The terrestrial vertebrate species observed or known to inhabit the potential area of concern or similar habitats were identified. The species were listed phylogenetically by habitat in tabular form and categorized as: (1) game species, (2) threatened or endangered species, (3) resident species, (4) migratory species, (5) restricted range species, (6) ubiquitous species and/or (7) high interest species.

Although density data were not specifically determined, each species tabulated was placed into one of four categories: A = abundant, C = common, u = uncommon or Ca = casual. This was determined by the in consultation with literature references and appropriate management personnel or people with expertise specific to the area, habitat, or species of concern.

Aquatic Organisms. Since no detailed data were available for the aquatic organisms inhabiting

the stream, field work was conducted. Samples of the macroinvertebrates were taken by use of modified Serber nets and turning of rocks. Four replicate samples were taken both above and below the perturbation source for comparison. Fish were searched for, but none were found. The macroinvertebrate samples were sorted taxonomically and tabled.

Literature and field data were summarized for terrestrial and aquatic vertebrates and aquatic macroinvertebrates of concern according to the level indicated in the scope of work. The species were categorized to determine habitat affinities and high interest status. The results are reported in tabular form (Tables 3-18 and 3-19). They are listed according to their various ecological classifications (Dalton et al. 1978; Durrant 1952; Hall and Kelson 1959; Hall 1981; Hayward et al. 1976). Terrestrial vertebrate species whose ranges appear to overlap the potential area of impact are listed. No discussion is included in this section of the report. The high interest species of concern are discussed individually in a separate section of this chapter as are the overall impacts by action.

The terrestrial portion of the project area could be inhabited by about 140 avian, 74 mammalian, 6 amphibian and 17 reptilian species. The stream could be inhabited by 20 different families in 9 orders of invertebrates. Some of these macroinvertebrates are high interest species since they provide forage to trout and other fishes in Lower Cottonwood Creek, a class 3 fishery. The high interest species are not mapped individually because their ranges are essentially ubiquitous and could not be meaningfully mapped. Their distribution is too broad to be of importance in a small area such as that of the Mine.

There are five distinct terrestrial wildlife habitats plus the small stream in the Mine plan area. Although these can be vegetatively divided into smaller units, the smaller units are not significant to wildlife distribution. The terrestrial habitats are: pinion juniper, grass aspen, cliff, mixed conifer, mixed mountain shrub and riparian. None of the habitats are unique or restricted to the area of the Mine plan area nor are they considered crucial/critical to the fauna inhabiting them in this area. The habitats in the portal vicinity have been impacted by mining activity, but the activities have been confined to a relatively small area. The steepness of the canyon walls has and will restrict habitat use and disruption by man.

During the initial study, the aquatic macroinvertebrate wildlife found on site in Cottonwood

Creek listed in Table 3-18 were taken above the portal and loadout facilities, and the data in Table 3-19 were taken below the portal and loadout facilities. (See Figure 3-1, Appendix 7-12, Appendix 3-10-7). Additional macroinvertebrate studies on this area are summarized in the appendices. The classes of terrestrial vertebrate wildlife are listed separately by relative abundance status according to season of occupancy by habitat type in Tables 3-20 through 3-22.

**Mammals**

Refer to Table 3-20.

**Birds**

Refer to Table 3-21.

**Reptiles and Amphibians**

Refer to Table 3-22.

**Species of Special Significance**

Refer to Table 3-23.

**Threatened and Endangered Species**

Refer to Table 3-24.

**Raptors**

Refer to Table 3-25.

Terms used in tables are defined as follows:

**Abundant**: Those organisms perennially observed in high numbers throughout the community the most obvious organisms in the community. **Common**: These species are easily trapped or observed in the community. **Uncommon**: Organisms that are not ordinarily encountered in the community. **Casual**: These species are seldom identified or only occasionally observed. **Resident**: Those species that are found in the community throughout the year. **Summer only**: These species breed in the area and migrate elsewhere in the winter. **Winter only**: Organisms that breed elsewhere and migrate into the communities listed. **High Interest**: Any species that is endangered, threatened or of economic or recreational value. **Game Species**: Any species that is hunted or trapped as a game animal and requires a hunting license. **Endangered**: Any species that is in immediate danger of extinction. **Threatened**: A species whose numbers are decreasing rapidly and likely to become endangered if the present trend continues. **Raptors**: Any bird that seizes and carries its prey by force. Typically, they are characterized by carnivorous habits,

great powers of flight, seize their prey with sharp curved claws and have a short curved beak.

It is projected that the area of potential impact in the mine plan area could possibly be occupied by or provide habitat for approximately 245 species of wildlife according to the Utah Division of Wildlife Resources (UDWR) publication No. 78 16: 74 mammal species, 140 bird species, 17 reptile species, 6 amphibian species, and 8 fish species. Sixty-one are of high interest to UDWR, and approximately 83 percent are protected by law. On site visits, however, reduced this potential number to approximately 187 species: 52 mammal species, 121 bird, 12 reptile, 2 amphibian and no fish species.

Mammals

Based on literature and onsite visits, the potential area of impact could provide habitat for approximately 51 species of mammal (Table 3-20). Approximately 30 percent are protected and considered of high interest to the State of Utah.

Snowshoe Hare

The snowshoe hare is present in and dependent upon the mixed conifer and nearby aspen and riparian habitats year-round. The impact of the proposed actions rate as 0 for this species.

Mountain Cottontail

The entire project represents a substantial value use area for cottontails. Due to the reproductive life history of the species and the extent of disturbance, the proposed actions are not likely to seriously alter the reproductive potential of the population. The impact of the proposed actions rate as 0 for this species.

Furbearers

Limited portions of the area of concern and adjacent areas provide substantial value habitats for a few species categorized by management agencies as furbearers: ermine, long tailed weasel, badger, and the stripped skunk. Although riparian habitats are important to these species, the species are wide spread and adaptable to the activities of man. The marten and wolverine are possible inhabitants of the mine site, but even if present they would occupy the upper reaches of the area and would not be seriously

impacted. The perturbation impact of the proposed actions on the furbearers rates as 0.

Small Mammals

Although small mammals do not qualify individually as high interest species, they represent a significant part of the ecosystem. The majority are herbivores and are the primary source of food for higher trophic levels, particularly raptors, canids and felids. This trophic importance warrants consideration, but since this project only involves the continuation of an ongoing operation, there will not be additional habitat loss. Subsidence is also projected to be minimal, so interruption of underground burrow systems is not a serious concern. It is important to note that most small mammal species of importance to predators do not occupy the rocky, steep slopes characteristic of most of the mining area. The perturbation impact of the proposed actions on the small mammals rates as 0.

Bobcat

The mine and adjacent areas provide substantial habitat for bobcats, although none were evidenced by observation or tracks, they are known to occupy or use all of the terrestrial habitats in the area of concern. The perturbation impact of the project rates as 1 for this species.

Mountain Lion (Cougar)

The Mine plan area provides substantial valuable, yearlong habitat for cougar. The animal ranges throughout the area, but its movements are often dictated by migration patterns of the primary food source, mule deer, and by human disturbance. The perturbation impact of the project on this species rates as 1.

Moose

The project site represents substantial value, yearlong range for the Southeastern Utah moose herd Joe's Valley drainage, but it is doubtful that moose have used or are using the specific site. The closest moose habitat is 4-5 miles upstream or downstream and even that is questionable. In addition, the steep, rocky terrain surrounding the riparian habitat in the area of concern is not the type of habitat that would normally be associated with moose. The perturbation impact of the project on moose rates as zero (0).

Birds

Based on literature and on-site visits, the potential area of impact could provide habitat for approximately 121 species of birds (Table 3-21). The project and adjacent areas potentially provide habitat for many raptors.

Tetra Tech, Inc. performed raptor nest surveys at the Fossil Rock Portal Area during 2016, 2017, 2018 and 2019. Two surveys were conducted in 2016, one on May 17, 2016 and one on June 17, 2016. In 2017, one survey was conducted on May 27 and 28, 2017. The suitable nesting habitat identified in the survey area was inspected, including stands of conifer, aspen (*Populus tremuloides*) or other trees, and cliff areas. Five nests known from the 2015 survey were monitored. The five known raptor nests were inactive during the 2016 and 2017 surveys. The nests were likely constructed by golden eagles based on their size. The nests were in good condition. No other new nests were identified in the portal survey area. A summary of the information reported in the raptor survey (annual) will be provided to the Division following the receipt and review of the survey by the permittee.

Golden Eagles

Golden eagles are common yearlong residents of the environs of the mine plan area. Suitable nesting habitat is widespread on the specific mine site and throughout the local area. Five inactive golden eagle nesting sites were found in 2015. Given the location of the nest sites, the perturbation impact of the project rates as 0 for this species.

Prairie Falcon

This relatively abundant species is a known yearlong resident of the general environs of the mine plan area and is a cliff nesting falcon, but none were observed or found on or in the immediately proximate areas to the project. It is possible but doubtful that the current level of activity has precluded their use of the canyon. There is ample cliff habitat sufficiently distant and not visible from the surface disturbance areas to accommodate this species. It is more likely that the steep and narrow nature of the canyon and the paucity of prey renders the site-specific area energetically undesirable. The perturbation impact on the project on this species rates as 0.

Kestrel

This species was found on and adjacent to the mine site and was actively resting and feeding within one hundred yards of the portal. This species likes riparian habitat and although quite adaptable to the activities of man is likely impacted slightly by such activities as occur on or near the portal. The stability of this falcon in the area is not in jeopardy, and the perturbation impact of the project rates as 1 for this species.

Blue Grouse

The blue grouse is a yearlong resident of the project area. In the fall and winter, they prefer the open stands of conifer and aspen in the higher elevations, but during the spring and summer they reverse migrate into the mountain brush and occasionally pinion juniper. These habitats are considered critical to the species as are the crucial periods of occupancy, but the habitats and birds are sufficiently removed from the mine facilities. The perturbation impact of the project on this species is considered as 0.

Ruffed Grouse

The ruffed grouse is a yearlong but not abundant resident of the project area. The perturbation impact of the project rates as 0 for this species.

Mourning Dove

Mourning doves normally inhabit the project and adjacent areas where they prefer the abundant pinion juniper and riparian habitats for nesting. The perturbation impact of the project on this species rates as no more than 1.

Passeriformes (Birds)

Many passerine species of high interest occupy the area, primarily on a seasonal basis. The perturbation impact of the project on this taxonomic group is rated as 0.

Reptiles and Amphibians

Based on literature and onsite visits, the area of potential impact could provide habitat for 17 species of reptile and 6 species of amphibian (Table 3-22). Reptile and amphibian species are protected, but only two of the reptile and one of the amphibian species are considered of high interest to the State of Utah.

Utah Milk Snake

The Utah milk snake is a yearlong resident animal of the project area and potentially could occupy all habitats. It is mostly nocturnal and is often found inside or under rotten wood or rocks. The impact of the project on this species rates as 0.

Utah Mountain Kingsnake

This species is a year round resident of the project area that prefers dense vegetation habitats near water. This coupled with the nocturnal habits of the species render impact beyond that which has already occurred unlikely. The population of the species should remain status quo, so the perturbation impact of the project on this species rates as 0.

Tiger Salmander

The tiger salamander is a yearlong resident animal potentially occupying any moist underground habitat or similarly moist above ground areas such as rotten logs, cellars or animal burrows. It is dependent upon open water, primarily in pools or ponds for reproduction and larval development and migrates to such areas on rainy or moist nights. Little of this habitat is present on site. The perturbation impact of the project on this species rates as 0.

The perturbation rating used in part of the application (Table 3-26) is explained above. Basically, it is a scale ranging from 0 -10 with 0 being little or no impact and 10 being the loss of the species.

Fish

Based upon early site studies, the macroinvertebrate community above the portal is considered healthy while that below the pollution source is considered under stress and unhealthy. Corrective measures have been taken at the site to control sediment and protect the stream. Subsequent studies have shown the macroinvertebrate populations to be stabilized and not severely impacted.

Refer to Appendix 2-1 for information documented in the Cottonwood Canyon Lease Environmental Impact Statement.

### 323 Maps and Aerial Photographs

#### 323.100 Reference Area Boundaries

The vegetation reference areas are shown on Map A, Appendix 3-9-1.

#### 323.200 Elevations and Location of Monitoring Stations

Plate 3-4 shows the location and elevation of the raptors nesting areas that are near the disturbed area. Elk and deer range are shown on Plate 3-2.

#### 323.300 Each Facility Used to Protect and Enhance Fish and Wildlife

The species and habitats within the permit area will be protected to the best of the applicant's ability. Wildlife habitat protection will be considered in the construction of future facilities. The sediment control systems are designed to protect and enhance environmental values by minimizing the sediment load from the disturbed area. Power poles are designed and installed with raptor protection. Additional information is provided in mitigation Section 330.333.

## 330 Operation Plan

### 331 Measures Taken to Disturb the Smallest Practicable Area

The Fossil Rock facilities and haul road were constructed prior to the creation of SMCRA regulations. No additional vegetative disturbance is anticipated beyond that encountered during exploratory drilling, potential permitted portal site expansion or that created by subsidence. Only additional facilities required to maintain the coal operation or satisfy environmental or safety requirements will be constructed.

### 332 Description of Anticipated Impacts of Subsidence

There is no anticipated subsidence associated with the mining in the current leases. No buildings or dwellings have been constructed on any surface that will be subject to subsidence within the mine plan area. Previous surveys have indicated that no substantial damage has occurred to vegetation as a result of subsidence within the area.

### 333 Plans to Minimize Disturbance

The mine site was disturbed during development activities from 1948-1967. As such no vegetative protection activities were implemented during development of the mine site. The presence of wildlife in the mine plan area indicates their adaptability to the impacts of the mine. As a result, the overall impacts to wildlife are expected to be very minor.

The permittee will make efforts to educate employees to the intricate values of the wildlife resources associated with the mine area. Mine employees will be encouraged to reduce speed while driving adjacent to the mine when wildlife and livestock are present. Discharge of firearms by employees will be prohibited on company-controlled property during mine operating hours.

Although no fish occupy Cottonwood Creek, the Applicant will take precautions to keep coal or other sediments generated by the operation of the mine from inadvertently entering the stream. The Applicant will set up buffer zones at the by-pass culvert inlet and outlet of Cottonwood Creek to protect the aquatic environment (see Figure 3-3). The extent of the buffer zone will be from the culvert outlet downstream 50 feet with a width from the road on the east to 50 feet west of the stream. Above the culvert, the extent of the buffer zone will be from the culvert inlet to a point 50 feet above the disturbed area. The width will be from the road on the east to the disturbed area on the west. Signs are posted indicating a buffer zone and indicate that the area should not be disturbed.

Wildlife habitats will be maintained or improved if disturbed by using native or other vegetation approved for reclamation for habitat improvement.

Livestock and wildlife will be protected from the effects of mining related subsidence to the extent possible. Surface cracks that open to the point of creating a physical hazard to livestock and wildlife will be mitigated. This mitigation may include but not limited to backfilling the cracks with available local native materials and soil, partially backfilling with imported fill, or simply reshaping of the nearby ground surface to lessen the offset or abruptness of the crack faces and depth. The repaired areas will then be reseeded with an approved seed mix appropriate to the area.

## 340 Reclamation Plan

### 341 Revegetation

Upon the permanent cessation of coal mining and reclamation operations at the Mine, the Operator will close, backfill, or otherwise permanently reclaim the affected areas in accordance with the R645 regulations and this reclamation plan.

#### 341.100 Reclamation Timetable

See Table 3-3.

#### 341.200 Descriptions

Seed Mixes - Two seed mixes are proposed for reclamation, the first seed mix is for the riparian community, the second is for the grassland-shrub community. Lists of the species for both seed mixes can be found in Appendix 3-9-1.

Seeding - Information from the test plots has been utilized together with proven reclamation results to arrive at the best treatment and seeding methods. After regrading and top soiling, the disturbed area will be mulched and seeded. The steeper areas (slopes greater than 2.5H:1V) will be hydroseeded or broadcast, and areas flat enough to safely allow operation of a drill seeder may be drill seeded or broadcast seeded. Regraded areas will be pocked/gouged creating numerous depressions that will hold moisture and provide a micro-climate for vegetation establishment. Hydro-seeding requires first seed, tackifier and wood fiber mulch (400 Ibs/acre) be mixed in a water slurry and applied. Refer to Section 355 for mulch requirements.

Riparian Community - During reclamation, the culverts will be removed, and the stream channels will be restored. The riparian seed mix (see Table A9-3, Appendix 3-9-1) will be used approximately 20-40 feet on each side of the rip-rap, leaving a total floodplain area of 50-60 feet.

Grassland - Shrub Community - The seed mix for the grassland - shrub community will be used on the entire mine site, with the exception of the riparian area. See Table A9-1, Appendix 3-9-1 for seed mix and application rates. Portions of the grassland - shrub community area may be flat enough to safely utilize a drill-seeder; however, the majority of this area will be on the steeper slopes and will thus be hydro-seeded or broadcast.

Containerized Stock - Following the seeding and mulching, containerized woody plant species will be planted at a rate of 90 individuals/acre (or 2% of the undisturbed density in equal proportions) within the riparian corridor. Wherever possible, this stock will be spatially arranged in clumps to maximize cover for wildlife. One proposed option is that fresh-cut willow shoots be used on the riparian area in lieu of containerized stock. These shoots would be cut from local sources along Cottonwood Creek and placed on 3' centers on each side of the reclaimed channels.

Mulch – Refer to Section 355.

Irrigation, Pest and Disease Control – Irrigation is not planned; however, hand set plantings may be given supplemental irrigation. No regulated pesticides will be used by the Applicant in the mine area unless previously approved by the UDOGM.

Revegetation Success **-** Success standards are show in 356.120.

### 341.300 Greenhouse Studies Field Trials

If additional testing is required for the purpose of demonstrating that reclamation as required by the State Program can be accomplished according to information given in the M&RP, the Applicant will comply.

In 1984, a test plot area was installed just north of the bathhouse at the Mine site. For a complete description of this test plot and record of yearly sampling, please refer to Appendix 3-9-2.

## 342 Fish and Wildlife

### 342.100 Enhancement Measures

Wildlife habitats will be maintained or improved if disturbed. This will be done by using native or other vegetation approved for reclamation or habitat improvement. No new actions will be undertaken that compromise wildlife or their use areas without prior approval by the appropriate management or regulatory agency.

### 342.200 Plants Used for Wildlife Habitat

The plant species in the reclamation seed mix are consistent with those presently grown in the area.

Nutritional Value - The nutritional value will be consistent with that of vegetation in the surrounding areas.

Cover - The goal of the Applicant is to establish plant species which will provide sufficient cover for the fish and wildlife of the area. The Applicant will use rocks and dead trees and shrubs when available as part of the reclamation planting surface preparation to enhance the reclaimed area for wildlife habit. Reshaping of the disturbed area will simulate the surrounding topography.

Ability to Support and Enhance -The plant species included in the proposed reclamation mixes can support and enhance the fish or wildlife habitat. Refer to Section 341.200 for additional information.

### 342.300 Cropland

Cropland is not a postmining land use.

### 342.400 Residential Public Service and Industrial Land Use

No residential, industrial or public service use is planned at the present time for the permit area following the termination of mining.

## 350 Performance Standards

### 351 General Requirements

The Applicant commits to conduct operations in accordance with the plans submitted In Sections R645-301-330 through R645-301-340 of the permit application.

### 352 Contemporaneous Reclamation

Contemporaneous reclaimed areas will be visually checked, should contemporaneous reclamation fail, the areas will be reseeded. Refer to Plate 3-6 for location of contemporaneous reclamation. Contemporaneous reclamation will not be done in areas the Mine Health and Safety Regulations require to be kept barren of vegetation (such as areas around mine ventilation openings).

Plant Species - Plant species used for temporary, contemporaneous reclamation with their respective justifications are listed below:
Agropyron dasystachyum --Thickspike Wheatgrass-- This grass species was chosen for its on-site adaptability of these climatic patterns, high salt tolerance, sod forming characteristics and rapid establishment capabilities.
Oryzopsis hymenoides--Indian Rice grass-- This grass species has excellent success on spoils establishment and has moderate salt tolerance qualities.
Astragalus cicer--Silklepod Milkvetch--This forb will be planted because it is sod forming, nitrogen fixing, has moderate salinity adaptation, has establishment qualities and for aesthetics values.
Melilotus officinalis--Yellow Sweetclover-- This species is an introduced forb that establishes readily on severe disturbed sites. It is also a nitrogen fixing plant that has high affinity for salt tolerance.

Note: seeding rates of species will be in equal proportions totaling 52 PLS per square foot. No

shrub or tree species are included in the seed mix for contemporaneous reclamation.

Seeding Methods - Slopes 1.51 or less will be either drill seeded or seeded by hydro seeder or hand broadcast methods. Slopes greater than 1.5:1 will be seeded by hydro seeder or hand broadcasting.

### 353 Revegetation: General Requirements

A vegetative cover will be established on the reclaimed areas to allow for the designated postmining land use. Water areas and surface areas of roads will not be revegetated. The revegetation will be in accordance with the approved permit and reclamation plan.

#### 353.100 Vegetative Cover

The seed mix proposed for revegetation is intended to provide vegetative cover that will be diverse, effective and permanent. The seed mixture was selected with respect to the climate, potential seedbed quality, erosion control, drought tolerance and the mixture's ability for rapid germination and succession.

Native Species - The vegetative mixture will be comprised of species native to the area, capable of achieving postmining land use. Diversity of species should allow utilization of plants by wildlife and by domestic livestock. The revegetative seed species will be purchased from suppliers who will certify their percentages of purity, percentages of maximum weed seed contents and the declaration of poisonous and noxious weed content.

Extent of Cover- Revegetation success at the mine will be based on comparison with the approved reference areas. Refer to Section 356 for additional information.

Stabilizing- The vegetative cover mixture is capable of stabilizing the soil surface from erosion.

#### 353.200 Reestablished Plant Species

The reestablished plant species have been selected to insure they are compatible with the approved postmining land use.

Seasonal Characteristics- The revegetation plant species will have the same growing season as the original vegetation or in this instance as the adjacent areas.

Self-generation- The reestablished plants are species capable of self-generation and plant succession.

Compatibility- The seed mixes for revegetation contain species compatible with the plants and animals in the permit area.

Federal and Utah Laws or Regulations- The seed mixture purchased to revegetate the mine area will contain no poisonous or noxious plants. No species will be introduced in the area without being approved by the UDOGM.

### 353.300 Vegetative Exception

The applicant does not require a vegetative exception at this time.

### 353.400 Cropland

The permit area contains no land designated as cropland for postmining land use. Prime farmland

### 354 Revegetation: Timing

The disturbed areas of the mine will be revegetated the first period of favorable planting conditions following final site preparation. Seeding will normally occur in October or November of the year, depending on climatic conditions at that time. This will allow little chance of premature germination, increase the likelihood of hibernation (or inactivity) of most seed predators and will allow seed emergence in early spring when moisture conditions are most favorable.

### 355 Revegetation: Mulching and Other Soil Stabilizing Practices

Hydromulching will consist of chopped straw, hay or wood fiber mixed with water and machine blown at the rate of 2,000 Ibs/acre. Suitable mulch and other soil stabilizing practices will be used on areas that have been regraded and covered by topsoil or topsoil substitutes. Mulching and revegetation will not be attempted on sheer rock outcrops.

The reclaimed area will be left in a roughened condition by subsequent ripping and/or tracking with the equipment. On flatter areas a ton per acre of noxious weed free straw will be incorporated into the soil during surface roughening to promote moisture retention.

Slopes 1.5H:1V will not hold topsoil; therefore these slopes will be revegetated without the application of topsoil. Seed for grasses and forbs will be incorporated in a water slurry with a tackifier and mulch material (400 lbs/acre) and applied. The hydromulch materials (2,000 lbs/acre) will then be applied as a separate application.

### 356 Revegetation: Standards for Success

The standards for revegetation success are detailed in Sections 342 and 353.

#### 356.100 Success of Revegetation

The success standards for approval will be judged on the effectiveness of the vegetation for postmining land use, the extent of cover in comparison to the reference area, and the standards outlined in Section 353. Ground cover, woody plant density, and shall be considered equal to their respective reference area counterparts, when there is 90 percent success at 90% statistical confidence. Vegetation monitoring for permanent reclamation will be conducted as indicated in Table 3-2.

#### 356.200 Standards for Success

Standards of success will be applied in accordance with the approved postmining land use. There is no portion of the disturbed area that has a postmining land use of grazing, pasture or crop land.

Fish and Wildlife Habitat - The success of revegetation for fish and wildlife habitat will be determined based on tree and shrub stocking and vegetative ground cover. At the time of bond release, trees and shrubs will be healthy, and at least 80 percent will have been in place for at least 60 percent of the applicable minimum period of responsibility. No trees and shrubs in place for less than two growing seasons will be counted in determining stocking adequacy. Vegetative ground cover will not be less than that required to achieve the approved postmining land use.

Industrial Commercial or Residential - The postmining land use for the permit area is not designated for industrial, commercial or residential use.

Previously Disturbed by Mining - The mine was previously disturbed by mining and was not reclaimed. There is no record of revegetation being done prior to 1977. The applicant will restore the vegetative cover, so it is at least equal in extent to the natural vegetation of the reference areas and capable of controlling erosion.

### 356.300 Siltation Structures

Siltation structures will be maintained until the disturbed area has been stabilized and revegetated. The structures will not be removed sooner than two years after the last augmented seeding.

### 356.400 Siltation Structure Removal

The land on which the siltation structure was located will be revegetated in accordance with the reclamation plan and R645-301-353 through R645-301-357.

## 357 Revegetation: Extended Responsibility Period

The applicant will be responsible for the success of revegetation for a period of ten years following the completion of reclamation activities. Vegetation parameters will equal or exceed the approved success standards during the last two years of the responsibility period.

When required the Applicant will comply with UDOGM approved husbandry practices which may include disease, pest, and vermin control and pruning, reseeding and transplanting required.

## 358 Protection of Fish, Wildlife, and Related Environmental Values

The Applicant will minimize disturbances and adverse impacts on fish, wildlife and their related environments as outlined in Section 333. The intermittent flow of streams within the area does not support a population of game fish; therefore, there are no fisheries within the permit area.

### 358.100 Existence of Endangered or Threatened Species

Coal mining will not be conducted where its operation might jeopardize the existence of endangered/threatened species or destruction/adverse modification of these species' critical habitat. There are no identified active aeries being occupied by high interest species of raptors, nor readily accessible reproductive sites for game species that are critical to perpetuation of the species. No active nest sites were identified during raptor surveys conducted in 2016 thru 2019.

Searches of federal databases as well as publications of the Utah Natural Heritage Program resulted in the determination that no listed threatened or endangered plants are likely to occur within the mine or adjacent area based on known distributions and habitat preferences of these taxa (November 2017) . Barneby Reed-mustard occurs in southern Emery County on the Chinle Formation amidst mixed shadscale, buckwheat, and ephedra communities. Jones cycladenia occurs in east-central Emery County on gypsiferous saline soils of the Chinle, Cutler, and Summerville Formations in cool desert shrub and juniper communities. Last chance townsendia occurs in southwest Emery County on the clay or clay/silt soils of Arapien and Mancos Shale Formations in salt desert shrub and pinyon-juniper communities. Winkler cactus occurs along the southern boundary of Emery County in salt desert shrub communities. And Wright fishhook cactus occurs in southwest Emery County on the Mancos Shale Formation in salt desert shrub and pinyon-juniper communities. The Forest Service sensitive species, canyon sweetvetch, has been identified from northwest Emery County but is not present within the mine or adjacent area (Harber, pers. comm., 1998).

| **Plants** | | Status | Present |
|---|---|---|---|
| Barneby Reed-Mustard | Schoenocrambe barnebyi | E | NP |
| Jones Cycladenia | Cycladenis humilis var. jonesii | T | NP |
| Last Chance Townsendia | Townsendia aprica | T | NP |
| Wright Fishhook Cactus | Sclerocactus wrightiae | E | NP |
| Winkler Pincushion Cactus | Pediocactus winkleri | T | NP |
| Despain Pincushion Cactus | Pediocactus despainii | E | NP |
| **Mammals** | | | |
| Utah Prairie Dog | Cynomys parvidens | T | NP |
| Canada Lynx | Lynx canadensis | T | NP |
| **Birds** | | | |
| Mexican Spotted Owl | Strix occidentalis lucida | T | NP |
| Western Yellow-billed Cuckoo | Coccyzus americanus | T | NP |
| **Fish** | | | |
| Bonytail Chub | Gila elegans | E | NP |
| Colorado Pikeminnow | Ptychocheilus lucius | E | NP |
| Humpback Chub | Gila cypha | E | NP |
| Razorback Sucker | Xyrauchen texanus | E | NP |
| **Amphibians & Reptiles** | | | |
| **None listed** | | | |

E - Endangered T - Threatened Extirpated - No longer occur in Utah C - Candidate
NP - Not Present (BLM, USFWS, FSEIS) P - Present (BLM, FSEIS)

For additional information contact: U. S. Fish and Wildlife Service, Telephone:(801) 975-3300

### 358.200 Bald and Golden Eagles

Coal mining and reclamation operations will be conducted in a manner protective of the bald or golden eagle. The applicant will report golden or bald eagle nests found within the permit boundaries and will proceed with operations in accordance with the UDOGM regulations and permitting commitments.

### 358.300 Taking of Endangered or Threatened Species

The applicant understands that there is no permission implied by these regulations for taking of endangered or threatened species, their nests or eggs

### 358.400 Replacement of Wetland and Riparian Vegetation

To mitigate the loss of approximately 2,000 feet of riparian community that was damaged when a portion of the North Fork of the Cottonwood Creek adjacent to the disturbed area of the Mine was diverted into a culvert. The main canyon culvert was extended approximately 300' upstream in late 1990. This extension impacted approximately 0.21 acres of riparian habitat.

The permittee (During April 1986) cut and collected approximately 3,500 12-18 inch long willow stems from local stock and placed them in cold storage. During the latter of part of May, 1986, these willow stems were planted at intervals of approximately six feet apart on both sides of the North Fork of the Cottonwood Creek for a distance of two miles below the disturbed area of the mine site. This willow shoot enhancement project was conducted by the permittee with the technical supervision of Mr. Larry Dalton of the Division of Wildlife Resources (1986).

As mitigation for this removal of riparian area, 20 small rock check dams were installed in the lower portion of Cottonwood Creek to enhance water retention and possible fish survival. This mitigation was performed in accordance with approval from DWR. Details on location and installation of these structures (as well as the culvert extension) are found in Appendix 7-13 of this MRP.

### 358.500 Manmade Wildlife Protection Measures

Electric Power Lines. Power lines within the Mine permit area are constructed to minimize hazards to raptors.

Potential Barriers. The mine has been operating approximately 70 years and little should now be done to change the design of the portal facilities to lessen the impacts. The wildlife inhabiting and utilizing the area of concern have likely acclimated to the present facilities and consequently adjusted their behavior including migration so that a modification of the facilities to providing corridors would be more adverse than leaving the facilities as they are.

Pond Protection. The applicant has no ponds containing hazardous concentrations of toxic-forming materials. Should it become necessary fences or other appropriate methods will

be used to exclude wildlife from ponds.

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TABLE 3-2

# TRAIL MOUNTAIN MINE
# FINAL RECLAMATION MONITORING

| TEN YEAR RESPONSIBILITY PERIOD | 1ST YEAR | 2ND YEAR | 3RD YEAR | 4TH YEAR | 5TH YEAR | 6TH YEAR | 7TH YEAR | 8TH YEAR | 9TH YEAR | 10TH YEAR |
|---|---|---|---|---|---|---|---|---|---|---|
| | QUALITATIVE OBSERVATIONS | | | | | | | | | |
| SPRING SITE VISIT | | ✸ | ✸ | ✸ | ✸ | ✸ | ✸ | ✸ | ✸ | ✸ |
| FALL SITE VISIT | | ✸ | ✸ | ✸ | ✸ | ✸ | ✸ | ✸ | ✸ | ✸ |
| | QUANTITIVE OBSERVATIONS | | | | | | | | | |
| COVER | | ✸ | ✸ | | ✸ | | | | ✸ | ✸ |
| FRENQUENCY | | ✸ | ✸ | | ✸ | | | | ✸ | ✸ |
| WOODY PLANT DENSITY | | ✸ | ✸ | | ✸ | | | | ✸ | ✸ |
| PRODUCTIVITY | | | | | | | | | ✸ | ✸ |

TABLE 3-3

## TRAIL MOUNTAIN MINE
## TYPICAL RECLAMATION SCHEDULE
## RECLAMATION TIME TABLE

| TEN YEAR RESPONSIBILITY PERIOD | MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER | JANURARY | FEBRUARY | MARCH | APRIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SURFACE FACILITY REMOVAL | | | | | | | | | | | | |
| COAL WASTE | | | | | | | | | | | | |
| CONTOUR TRENCHING | | | | | | | | | | | | |
| PORTAL SEALING | | | | | | | | | | | | |
| EATHMOVING AND RECONTOURING | | | | | | | | | | | | |
| FERTILIZATION | | | | | | | | | | | | |
| SEEDBED PREPARATION GRASSLAND-SHRUB | | | | | | | | | | | | |
| SEDIMENT POND | | | | | | | | | | | | |
| SEEDBED PREPARATION RIPARIAN | | | | | | | | | | | | |
| MULCH | | | | | | | | | | | | |
| CONTAINERIZED STOCK | | | | | | | | | | | | |

**Table 3-4**

## Table 9-1
## SPECIES PRESENCE LIST: RIPARIAN PLANT COMMUNITY

| Species* (Total =86) | Common Name |
|---|---|
| **Trees** | |
| *Abies concolor (*Gord. & Glen.) Lindl. | White Fir |
| *Acer glabrum* Torr. | Rocky Mountain Maple, Smooth Maple |
| *Acer grandidentatum* Nutt. | Bigtooth Maple |
| *Betula occidentalis* Hook. | Water Birch |
| *Juniperus scopulorum* Sarg. | rocky Mountain Juniper |
| *Picea pungens* Engelm. | blue Spruce |
| *Pinus edulis* Engelm. | Pinyon Pine |
| *Populus angustifolia* James | Narrowleaf Cottonwood |
| *Pseddotsuga menziesii* (Mirb. ) Franco | Douglas Fir |
| ***Shrubs and Vines (19)*** | |
| *Amelanchier alnifolia (Nutt.) Nutt.* | Saskatoon Serviceerry |
| *Amelanchier utahensis* Koehne | Utah Serviceberry |
| *Artemisia tridentata* Nutt. | Big Sage |
| *Cercocarpus ledifolius* Nutt. | Curlleaf Mountain Mahogany |
| *Chrysothamnus nauseosus* (Pall. ) Britton | Rubber Rabbitbrush |
| *Chrysothamnus viscidiflorus* (Hook.) Nutt. | Douglas or Yellowbrush Rabbitbrush |
| *Clematis columbiana* (Nutt.) Torr. & Gray | Columbian Clematis, Virgin's Bower |
| *Clematis ligusticifolia* Nutt. | Western Virgin's Bower |
| *Cornus stolonifera* Michx. | Redosier Dogwood |
| *Gutierrezia sarothrae* (Pursh) Britton | Broom Snakeweed |
| *Holodiscus dumosus* (Hook.) Heller | Bush Oceanspray |
| *Mahonia repens* G. Don | Oregon Grap, Creeping Barberry |
| *Prunus virginiana* L. | Chokecherry |
| *Ribes cereum* Dougl. | Wax Currant |
| *Rosa Woodsii* Lindl. | Wild Rose |
| *Salix bebbiana* Sarg. | Bebb Willow |
| *Salix erigua* Nutt. | Coyote Willow |
| *Sambucus caerulea* Raf. | Elderberry |
| *Symphoricarpos oreophilus* A. Gray | Mountain Snowberry |
| **Grasses, Sedges, and Rushes (10)** | |
| *Agropyron Spicatum* (Pursh) Scribn. & Smith | Bluebunch Wheatgrass |
| *Agropyron trachycaulum* (Link) Malte | Slender Wheatgrass |
| **(a)** *Bromus tectorum* L. | Cheatgrass |
| *Carex* sp. L. | Sedge |
| *Dactylis glomeratat* L. | Orcharg Grass |
| *Elymus cinereus* Scribn.& Smith | Wildrye |
| *Juncus balticus* L. | Artic Rush |
| *Oryzopsis hymenoides* (Roem. & Schult.) Ricker | Indian Ricegrass |
| *Poa pratensis* L. | Kentucky Bluegrass |
| *Typha latifolia* L. | Common Cattail |

**Table 3-4**

## Table 9-1 Continued
## SPECIES PRESENCE LIST: RIPARIAN PLANT COMMUNITY

| | Species* | Common Name |
|---|---|---|
| | **Forbs (48)** | |
| | *Achillea millefolium* L. | Yarrow |
| | *Aquilegia flavescens* S. Wats. | Yellow Columbine |
| | *Arabis holboellii* Hornem. | Rock Cress |
| | *Artemisia ludoviciana* Nutt. | Louisiana Sage, Wormwood |
| | *Aster chilensis* Nees. | Aster |
| | *Astragalus* sp. | an unidentified white-flowered species |
| | *Astragalus convallarius* Green | Tember Poisonweed |
| | *Astragalus lentiginosus* Dougl. Var. *araneosus* (Sheld.) Barneby | Specklepod Locoweed |
| | *Astragalus tenellus* Pursh. | Loosflower Milkkvetch |
| | *Castilleja applegatea* Fern. | Indian Paintbrush |
| | *Castilleja linariaefolia* Benth. | Wyoming Painted Cup |
| | *Chaenactis douglasii* (Hook. ) Hook. & Arn. | Chaenactis |
| | *Cirsium undulatem* (Nutt>) Spreng. | Wavyleaf Thistle |
| | *Cirsium vulgare* (Savi) Tenore | Thistle |
| | *Coryphantha vivipara* Britton & Brown | Mammillaria |
| | *Cryptantha Humilis* (Green) Payson | Cryptantha, Dwarf Catseye |
| | *Descurainia richardsonii* (Sweet) O.E. Schulz. | Tansymustard |
| | *Dodecatheon pulchellum* (Raf.) Merrill | Shooting Star |
| | *Equisetum arvense* L. | Field Horsetail, Scouring Rush |
| | *Erysimum asperum* (Nutt.) DC | Western Wallflower |
| | *Fragaria vesca* L. | Strawberry |
| | *Galium aparine* L. | Catchweek Bedstraw |
| | *Galium multiflorum* Kellogg | Shrubby Bedstraw |
| | *Geranium fremontii* Torr. | Fremont Geranium |
| | *Glycyrrhiza lepidota* Pursh | American Licorice |
| | *Habenaria hyperborea* (L.) R. Br. | Northern Green Bog Orchid |
| | *Hedysarum boreale* Nutt. | Northern Sweetvetch |
| | *Ipomopsis aggregata* V. Grant | Skyrocket Gilia, Scarlet Gilia |
| **(a)** | *Lappula redowskii* (Hornem.) Green | Stick Seed |
| | *Lathyrus lanszwertii* Kellogg | Thickleaf Sweetpea |
| | *Lipdium montanum* Nutt. | Mountain Pepperweed |
| | *Lesquerella intermedia* (S Wats.) Heller | Bladderpod |
| **(a)** | *Lithospermum arvense* L. | Stoneseed |
| **(a)** | *Malcolmia africana* (L.) R. Br. | African Mustard |
| | *Opuntia polyacantha* Haw. | Plains Prickly Pear |
| | *Pestemon eatoni* A. Gray | Eaton's Penstemon |
| | *Penstemon thompsoniae* (A. Gray) Rydb. | Thompson's Penstemon |
| | *Phlox hoodii* Rich.) | Hood's Phlox |
| | *Ranunculus cymbalaria* Pursh | Rocky Mountain Buttercup |
| | *Senecio multilobatus* Torr. & Gray | Lobeleaf Groundsel |
| **(a)** | *Sisymbrium altissimum* L. | Tumblemustard |
| | *Solidago canadensis* L. | Goldenrod |
| | *Stanleya pinnata* (Pursh) Britton | Prince's Plume |
| | *Taraxacum officinale* Weber | Common Dandelion |

Table 3-4

## Table 9-1 Continued
## SPECIES PRESENCE LIST: RIPARIAN PLANT COMMUNITY

| Species* | Common Name |
|---|---|
| **Forbs (con't)** | |
| *Trifolium repens* L. | White Clover |
| *Urtica dioica* L. | Stinging Nettle |
| *Valeriana edulis* Nutt. | Edible Valerian |
| *Viola adunca* J.E. Smith | Violet |

**(a)** annual
* Taxonomy according to Holmgren and Reveal, 1966; Welsh and More, 1973; and Arnow and Wyckoff, 1977.

## Table 3-5

### Table 9-2
### RIPARIAN TREE DATA*

| Species | No. of Individuals | Density Trees/Acre | Relative % Density | Basal Area ($in^2$) | Relative % Dominance | % Cover | Relative % Cover | % Frequency | % ΣF | Importance Value | Relative Importance | C x F Index† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trees** | | | | | | | | | | | | |
| *Populus angustifolia* | 39 | 85.6 | 97.5 | 2287.4 | 99.3 | 40 | 100 | 100 | 90.9 | 387.7 | 96.6 | 9090 |
| *Prunus virginiana* | 1 | 2.2 | 2.5 | 15.9 | 0.7 | 0 | 0 | 10 | 9.1 | 12.3 | 3.1 | 0 |
| Totals | 40 | 87.8 | 100 | 2303.3 | 100 | 40 | 100 | 110 | 100 | 400 | 99.7 | 9090 |
| **Saplings and Seedlings** | | | | | | | | | | | | |
| *Populus angustifolia* | 38 | 847.4 | 95 | | | | | 100 | 83.3 | 178.3 | 89.2 | |
| *Picea pungens* | 1 | 22.3 | 2.5 | | | | | 10 | 8.3 | 10.8 | 5.4 | |
| *Juniperus scopulorum* | 1 | 22.3 | 2.5 | | | | | 10 | 8.3 | 10.8 | 5.4 | |
| Totals | 40 | 892 | 100 | | | | | 120 | 99.9 | 199.9 | 100 | |
| **Trees plus Saplings and Seedlings** | | | | | | | | | | | | |
| *Populus angustifolia* | 77 | 933 | 96.2 | | | | | | | | | |
| *Picea pungens* | 1 | 22.3 | 1.3 | | | | | | | | | |
| *Juniperus scopulorum* | 1 | 22.3 | 1.3 | | | | | | | | | |
| *Purnus virginiana* | 1 | 2.2 | 1.3 | | | | | | | | | |
| Totals | 80 | 979.8 | 100.1 | | | | | | | | | |

* Tree density and frequency by the point-quarter method; cover by the line intercept method.
† Maxium possible value is 100 x 100 = 10,000.

Table 3-6

## Table 9-3
## RIPARIAN UNDERSTORY VEGETATION ANALYSIS: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 30 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index† |
|---|---|---|---|---|---|---|---|---|---|
| **Tree Seedling and Saplings*** | | | | | | | | | |
| *Betula occidentalis* | 0.07 | 3.3 | 1 | 0.20 | 0.49 | 0.03 | 0.72 | 0.24 | 0.10 |
| *Juniperus scopulorum* | 0.68 | 16.7 | 4 | 1.91 | 2.47 | 0.11 | 4.49 | 1.50 | 4.72 |
| *Populus angustifolia* | 3.93 | 33.3 | 14 | 11.06 | 4.92 | 0.38 | 16.36 | 5.45 | 54.42 |
| *Pseudotsuga menziesii* | 0.67 | 6.7 | 2 | 1.89 | 0.99 | 0.05 | 2.93 | 0.98 | 1.87 |
| Subtotal | 5.35 | 60.0 | 21 | 15.06 | 8.87 | 0.57 | 24.50 | 8.17 | 61.11 |
| **Shrubs** | | | | | | | | | |
| *Clematis ligustioifloia* | 1.17 | 50.0 | 37 | 3.29 | 7.39 | 1.01 | 11.69 | 3.90 | 24.31 |
| *Cornus stolonifera* | 0.07 | 3.3 | 0 | 0.20 | 0.49 | 0.00 | 0.69 | 0.23 | 0.10 |
| *Rosa woodsii* | 0.77 | 10.0 | 5 | 2.17 | 1.48 | 0.14 | 3.79 | 1.26 | 3.28 |
| *Symphoricarpos oreophilus* | 0.50 | 13.3 | 4 | 1.41 | 1.97 | 0.11 | 3.49 | 1.16 | 2.78 |
| Subtotal | 2.51 | 76.6 | 46 | 7.07 | 11.33 | 1.26 | 19.66 | 6.55 | 30.47 |
| **Grasses** | | | | | | | | | |
| *Daotylis glomerata* | 4.05 | 50 | 500 | 11.39 | 7.39 | 13.06 | 31.84 | 10.61 | 84.17 |
| *Poa pratensis* | 5.54 | 76.7 | 1,945 | 15.59 | 11.34 | 53.06 | 79.99 | 26.67 | 176.79 |
| Subtotal | 9.59 | 126.7 | 2,445 | 26.98 | 18.73 | 66.12 | 111.83 | 37.28 | 260.96 |

* Understory data measured by quadrats. See tree Tables for canopy data measured by point-quarter and line intercept methods.

**Table 3-6**

**Table 9-3 Continued**

**RIPARIAN UNDERSTORY VEGETATION ANALYSIS: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS**

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 30 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index† |
|---|---|---|---|---|---|---|---|---|---|
| **Forbs** | | | | | | | | | |
| *Achillea millefolium* | 0.26 | 16.7 | 39 | 0.73 | 2.47 | 1.06 | 4.26 | 1.42 | 1.8 |
| *Aster chilensis* | 7.77 | 96.7 | 421 | 21.86 | 14.29 | 11.48 | 47.63 | 15.88 | 312.38 |
| *Artemisia ludoviciana* | 0.26 | 20 | 21 | 0.73 | 2.96 | 0.57 | 4.26 | 1.42 | 2.16 |
| *Astragalus lentiginosus* | 0.11 | 10 | 6 | 0.31 | 1.48 | 0.16 | 1.95 | 0.65 | 0.46 |
| *Castillea applegatei* | 0.33 | 10 | 9 | 0.93 | 1.48 | 0.25 | 2.66 | 0.89 | 1.38 |
| *Castillea linariaefolia* | 0.02 | 6.7 | 2 | 0.06 | 0.99 | 0.05 | 1.1 | 0.37 | 0.06 |
| *Cirsium undulatum* | 0.53 | 66.7 | 31 | 1.49 | 9.86 | 0.85 | 12.2 | 4.07 | 14.69 |
| Equisetum arvense | 6.51 | 90 | 431 | 18.32 | 13.3 | 11.76 | 43.38 | 14.46 | 243.66 |
| *Fragaria vesca* | 0.003 | 3.3 | 1 | 0.01 | 0.49 | 0.03 | 0.53 | 0.18 | 0.01 |
| *Galium multiflorum* | 0.03 | 3.3 | 2 | 0.08 | 0.49 | 0.05 | 0.62 | 0.21 | 0.04 |
| *Glycyrrhisa lepidota* | 0.12 | 13.3 | 7 | 0.34 | 1.97 | 0.19 | 2.5 | 0.83 | 0.67 |
| *Hedysarum boreale* | 0.17 | 6.7 | 3 | 0.48 | 0.99 | 0.08 | 1.55 | 0.52 | 0.48 |
| *Solidago canadensis* | 0.6 | | 36 | 1.69 | 0.49 | 0.98 | 3.16 | 1.05 | 0.83 |
| *Habenaria hyperborea* | 0.03 | 3.3 | 3 | 0.08 | 0.49 | 0.08 | 0.65 | 0.22 | 0.04 |
| *Taraxacum officinals* | 1.26 | 53.3 | 139 | 3.55 | 7.88 | 3.79 | 15.22 | 5.07 | 27.97 |
| *Trifolium repens* | 0.01 | 3.3 | 3 | 0.03 | 0.49 | 0.08 | 0.6 | 0.2 | 0.04 |
| Subtotal | 18.01 | 403.3 | 1,154 | 50.69 | 60.12 | 31.46 | 142.27 | 47.44 | 606.67 |
| **Cryptogams** | | | | | | | | | |
| Lichens | 0.08 | 10 | - | 0.23 | 1.48 | - | 1.71 | 0.57 | 0.34 |
| Subtotal | 0.08 | 10 | - | 0.23 | 1.48 | - | 1.71 | 0.57 | 0.34 |
| Total: Living Plants | 35.54 | 676.60 | 3,666 | 100.03 | 100.53 | 99.41 | 299.97 | 100.01 | 959.55 |

| Non-Living Cover | |
|---|---|
| Litter | 50.56 |
| Rock | 2.63 |
| Soil | 8.6 |
| Total | 61.79 |

**Table 3-7**

## Table 9-4
## SPECIES PRESENCE LIST: PINYON-JUNIPER PLANT COMMUNITY

| Species (Total = 62) | Common Name |
|---|---|
| **Trees (6)** | |
| *Abies concolor* (gord. & Glend.) Lindl. | White Fir |
| *Juniperus osteosperma* (Torr.) Little | Utah Juniper |
| *Juniperus scopulorum* Sarg. | Rocky Mountain Juniper |
| *Pinus edulis* Engelm. | Pinyon Pine |
| *Pinus flexilis* James | Limber Pine |
| Pseudotsuga menziesii (Mirb.) Franco | Douglas Fir |
| **Shrubs (13)** | |
| *Amelanchier utahensis* (Nutt.) Nutt. | Utah Serviceberry |
| *Artemisia tridentata* Nutt. | Big Sage |
| *Atriplex confertifolia* (Torr. & Frem.) S. Wats. | Shadscale |
| *Cercocarpus ledifolius* Nutt. | Curlleaf Mountain Mahogany |
| *Chrysothamnus nauseosus* (Pall.) Britton | Rubber Rabbitbrush |
| *Chrysothamnus viscidiflorus* (Hook.) Nutt. | Douglas or Yellowbrush Rabbitbrush |
| *Ephedra viridis* (Cov.) | Green Ephedra, Mormon Tea, Joint Fir |
| *Gutierrezia sarothrae* (Pursh) Britton | Broom Snakeweek |
| *Holodiscus dumosus* (Hook.) Heller | Bush Oceanspray |
| *Mahoia repens* G. Don | Oregon Grape, Greeping arberty |
| *Pachistima myrsinites* (Pursh) Raf. | Mountain Lover |
| *Physocarpus malvaceus* (Green) Kuntze | Mallow Ninebark |
| *Symphoricarpos oreophilus* A. Gray | Mountain Snowberry |
| **Grasses (7)** | |
| *Agropyron spicatum* (Pursh) Scrib. & Smith | Bluebunch Wheatgrass |
| *Agropyron trachycaulum* (Link) Malte | Slender Wheatgrass |
| *Bromus inermis* Leyss. | Smooth Brome |
| *Bromus tectorum* L. | Cheatgrass |
| *Oryzopsis hymenoides* (Roem. & Schult.) Ricker | Indian Ricegrass |
| *Poa secunda* Presl | Sandberg's Bluegrass |
| *Poa* sp. | an unidentified bluegrass species |

**Table 3-7**

## Table 9-4 Continued
## SPECIES PRESENCE LIST: PINYON-JUNIPER PLANT COMMUNITY

| | Species | Common Name |
|---|---|---|
| | **Forbs (36)** | |
| | *Antennaria rosea* Greene | Rose Pussytoes, Everlasting |
| | *Arabis drummondii* A. Gray | Drummond's Rock Cress |
| | *Arabis holboellii* Hornem. | Rockcress |
| | *Arabis pendulina* Greede | Rockcress |
| | *Artemisia ludoviciana* Nutt. | Louisiana Sage, Wormwood |
| | *Chenopodium fremontii* S. Watts | Fremont's Goosfoot, Pigweed |
| | Cirsium undulatum (Nutt.) Spreng | Wavyleaf Thistle |
| | *Coryphantha vivipara* Britton & Brown | Mammillaria |
| | *Cryotantha humilis* (Greene) Payson | Cryptantha, Dwarf Catseye |
| * | *Cryptogramma stelleri* (Gmel.) Prantl | Rockbrake |
| (a) | *Descurainia pinnata* (Walt.) Britton | Tansymustard |
| | *Descurainia richardsonii* (Sweet) O.E. schulz | Tansymustard |
| | *Erigeron engelmannii* A. Nels. | Englmann's Fleabane |
| | *Eriogonum corymbosum* Benth. | Buckwheat |
| | *Galium aparine* L. | Catchweed Bedstraw |
| | *Galium multiflorum* Kellogg | Shrubby Bedstraw |
| | *Haplopappus nuttallii* Torr. & Gray | Golden Weed |
| | *Heterotheca villosa* Welsh & Moore | Golden Aster |
| | *Hymenopappus filifolius* Hook. | Fineleaf Hymenopappus |
| | *Ipomopsis aggregata* V. Grant | Skyrocket Gilia, Scarlet Gilia |
| (a) | *Lappula redoskii* (Hornem.) Greene | Stickweed |
| | *Lepidium montanum* Nutt. | Mountain Pepperweed |
| | *Leptodactylon pungens* (Torr.) Nutt. | Preckly Phlox |
| | *Leucelene ericoides* (Torr.) Green | Fleabane |
| (a) | *Lithospermum arvense* L. | Stoneseed |
| | *Opuntia polyacantha* Haw. | Plains Prickly Pear |
| | *Penstemon eatonii* A. Gray | Eaton's Penstemon |
| | *Penstemon thompsoniae* (A. Gray) Rydb. | Thompson's Penstemon |
| | *Petradoria pumila* (Nutt.) Greene | Rock Goldenrod |
| | *Phlox hoodii* Rich. | Hood's Phlox |
| | *Senecio integerimus* Nutt. | Groundsel, Old Man |
| | *Senecio multilabatus* Torr. & Gray | Lobeleaf Groundsel |
| | *Sisymbrium linifolium* Nutt. | Tumblemustard |
| | *Solidago canadensis* L. | Goldenrod |
| | *Stanleya pinnata* (Pursh) Britton | Desert Prince's Plume |
| | *Townsendia incana* Nutt. | Hoary Townsendia |

* *Fern*
**(a)** *annual*

## Table 3-8

### Table 9-5
### PINYON-JUNIPER TREE DATA*

| Species | No. of Individuals | Density Trees/Acre | Relative % Density | Basal Area ($in^2$) | Relative % Dominance | % Cover | Relative % Cover | % Frequency | % ΣF | Importance Value | Relative Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trees** | | | | | | | | | | | | |
| *Juniperus scopulorum* | 6 | 14.9 | 15.0 | 433.0 | 10.9 | 3.1 | 14.9 | 60 | 30 | 70.8 | 17.7 | 447.0 |
| *Pinus edulis* | 27 | 66.9 | 67.5 | 2960.4 | 74.2 | 11.0 | 52.9 | 90 | 45 | 239.6 | 59.9 | 2380.5 |
| *Pinus flexilis* | 1 | 2.5 | 2.5 | 103.8 | 2.6 | 4.2 | 20.2 | 10 | 5 | 30.3 | 7.6 | 101.0 |
| *Pseudotsuga menziesii* | 6 | 14.9 | 15.0 | 490.6 | 12.3 | 2.5 | 12.0 | 40 | 20 | 59.3 | 14.8 | 240.0 |
| Totals | 40 | 99.2 | 100.0 | 3987.8 | 100.0 | 20.8 | 100.0 | 200 | 100 | 400.0 | 100.0 | 3168.5 |
| **Saplings and Seedlings** | | | | | | | | | | | | |
| *Juniperus scopulorum* | 8 | 26.8 | 20.0 | | | | | 50.0 | 23.8 | 43.8 | 21.9 | |
| *Pinus edulis* | 19 | 63.6 | 47.5 | | | | | 80.0 | 38.1 | 85.6 | 42.8 | |
| *Pinus flexilis* | 2 | 6.7 | 5.0 | | | | | 20.0 | 9.5 | 14.5 | 7.2 | |
| *Pseudotsuga menziesii* | 11 | 36.8 | 27.5 | | | | | 60.0 | 28.6 | 56.1 | 28.1 | |
| Totals | 40 | 133.9 | 100.0 | | | | | 210.0 | 100.0 | 200.0 | 100.0 | |
| **Trees plus Saplings and Seedlings** | | | | | | | | | | | | |
| *Juniperus scopulorum* | 14 | 41.7 | 17.5 | | | | | | | | | |
| *Pinus edulis* | 46 | 130.5 | 57.5 | | | | | | | | | |
| *Pinus flexilis* | 3 | 9.2 | 3.8 | | | | | | | | | |
| *Pseudotsuga menziesii* | 17 | 51.7 | 21.2 | | | | | | | | | |
| Totals | 80 | 233.1 | 100.0 | | | | | | | | | |

* Tree density, dominance, and frequency by the point-quarter method; cover by the line intercept method.

**Table 3-9**

**Table 9-6**

## PINYON-JUNIPER UNDERSTORY VEGETATION ANALYSIS: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 51 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Tree Seedling and Saplings*** | | | | | | | | | |
| *Juniperus scopulorum* | 0.12 | 3.92 | 2 | 0.51 | 1.03 | 0.34 | 1.88 | 0.63 | 0.53 |
| *Pinus edulis* | 0.29 | 1.96 | 0 | 1.24 | 0.52 | 0 | 1.76 | 0.59 | 0.64 |
| *Pseudotsuga menziesii* | 0.53 | 3.92 | 5 | 2.26 | 1.03 | 0.85 | 4.41 | 1.38 | 2.33 |
| Subtotal | 0.94 | 9.8 | 7 | 4.01 | 2.58 | 1.19 | 8.05 | 2.6 | 3.5 |
| **Shrubs** | | | | | | | | | |
| *Amelanchier utahensis* | 4.00 | 23.5 | 7 | 17.09 | 6.18 | 1.19 | 24.46 | 8.15 | 105.62 |
| *Artemisia tridentata* | 0.08 | 2.0 | 1 | 0.34 | 0.52 | 0.17 | 1.03 | 0.34 | 0.18 |
| *Gutierresia sarothrae* | 0.01 | 2.0 | 1 | 0.04 | 0.52 | 0.17 | 0.73 | 0.24 | 0.02 |
| *Symphoricarpos oreophilus* | 0.02 | 3.9 | 1 | 0.09 | 1.03 | 0.17 | 1.29 | 0.43 | 0.09 |
| Subtotal | 4.11 | 31.4 | 10 | 17.56 | 8.25 | 1.70 | 27.51 | 9.16 | 105.91 |
| **Grasses** | | | | | | | | | |
| *Agropyron spicatum* | 0.59 | 7.84 | 21 | 2.52 | 2.06 | 3.58 | 8.16 | 2.72 | 5.19 |
| *Agropyron trachycaulum* | 11.27 | 84.31 | 363 | 48.16 | 22.17 | 61.95 | 132.28 | 44.09 | 1067.71 |
| *Orysopsis hymenoides* | 0.12 | 3.92 | 1 | 0.51 | 1.03 | 0.17 | 1.17 | 0.57 | 0.53 |
| *Poa secunda* | 1.01 | 27.45 | 22 | 4.32 | 7.22 | 3.75 | 15.29 | 5.10 | 31.19 |
| Subtotal | 12.99 | 123.52 | 407 | 55.51 | 32.48 | 69.45 | 148.74 | 52.48 | 1104.62 |

* Understory data measured by quadrats. See tree Tables for canopy data measured by point-quarter and line intercept methods.

Table 3-9

Table 9-6 Continued

PINYON-JUNIPER UNDERSTORY VEGETATION ANALYSIS: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 51 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Forbs** | | | | | | | | | |
| *Antennaria rosea* | 0.1 | 5.88 | 8 | 0.43 | 1.55 | 1.37 | 3.35 | 1.12 | 0.67 |
| *Arabis drummondii* | 0.04 | 7.84 | 5 | 0.17 | 2.06 | 0.85 | 3.08 | 1.03 | 0.35 |
| *Arabis pendulina* | 0.04 | 1.96 | 10 | 0.17 | 0.52 | 1.71 | 2.4 | 0.8 | 0.09 |
| *Aster chilensis* | 0.07 | 3.92 | 4 | 0.3 | 1.03 | 0.68 | 2.01 | 0.67 | 0.31 |
| *Chenopodium fremontii* | 0.02 | 3.92 | 2 | 0.09 | 1.03 | 0.34 | 1.46 | 0.49 | 0.09 |
| *Cirsium undulatum* | 0.1 | 1.96 | 1 | 0.43 | 0.52 | 0.17 | 1.12 | 0.37 | 0.22 |
| *Cryptantha humilis* | 0.01 | 1.96 | 1 | 0.04 | 0.52 | 0.17 | 0.73 | 0.24 | 0.02 |
| *Cryptogramma stelleri* † | 0.02 | 1.96 | 1 | 0.09 | 0.52 | 0.17 | 0.78 | 0.26 | 0.05 |
| *Descurainia richardsonii* | 0.07 | 5.88 | 37 | 0.3 | 1.55 | 6.31 | 8.16 | 2.72 | 0.47 |
| *Erigeron engelmannii* | 0.03 | 5.88 | 3 | 0.13 | 1.55 | 0.51 | 2.19 | 0.73 | 0.2 |
| *galium multiflorum* | 0.11 | 7.84 | 23 | 0.47 | 2.06 | 3.92 | 6.45 | 2.15 | 0.97 |
| *Haplopappus nuttallii* | 0.29 | 17.64 | 17 | 1.24 | 4.64 | 2.9 | 8.78 | 2.93 | 5.64 |
| *Lappula redowskii* | 0.01 | 1.96 | 2 | 0.04 | 0.52 | 0.34 | 0.9 | 0.3 | 0.02 |
| *Lepidium montanum* | 0.16 | 3.92 | 5 | 0.68 | 1.03 | 0.85 | 2.56 | 0.85 | 0.7 |
| *Penstemon eatoni* | 0.02 | 1.96 | 2 | 0.09 | 0.52 | 0.34 | 0.95 | 0.32 | 0.05 |
| *Phlox hoodii* | 0.92 | 31.37 | 31 | 3.93 | 8.25 | 5.29 | 17.47 | 5.82 | 32.42 |
| *Senecio integerremus* | 0.04 | 5.88 | 4 | 0.17 | 1.55 | 0.68 | 2.4 | 0.8 | 0.26 |
| *Senecio multilobatus* | 0.09 | 7.84 | 6 | 0.38 | 2.06 | 1.02 | 3.46 | 1.15 | 0.78 |
| Subtotal | 2.14 | 119.57 | 162 | 9.15 | 31.48 | 27.62 | 68.25 | 22.75 | 43.31 |

† Fern

**Table 3-9**

**Table 9-6 Continued**

**PINYON-JUNIPER UNDERSTORY VEGETATION ANALYSIS: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS**

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 51 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Cryptogams** | | | | | | | | | |
| Moss | 0.57 | 23.53 | | 2.44 | 6.19 | | 8.63 | 2.88 | 15.1 |
| Lichens | 2.65 | 72.55 | | 11.32 | 19.09 | | 30.4 | 10.13 | 215.99 |
| Subtotal | 3.22 | 96.08 | | 13.76 | 25.28 | | 39.03 | 13.01 | 231.09 |
| Total: Living Plants | 21.35 | 380.32 | 586 | 99.99 | 100.07 | 99.96 | 291.58 | 100.00 | 1488.43 |
| Non-Living Cover | | | | | | | | | |
| Litter | 26.02 | | | | | | | | |
| Rock | 27.27 | | | | | | | | |
| Soil | 22.57 | | | | | | | | |
| Total | 75.86 | | | | | | | | |

**Table 3-10**

## Table 9-7
## SPECIES PRESENCE LIST: GRASSLAND-SHRUB COMMUNITY

| Species (Total = 37) | Common Name |
|---|---|
| **Trees (3)** | |
| *Abies concolor* (gord. & Glend.) Lindl. | White Fir |
| *Juniperus scopulorum* Sarg. | Rocky Mountain Juniper |
| Pseudotsuga menziesii (Mirb.) Franco | Douglas Fir |
| **Shrubs (11)** | |
| *Amelanchier utahensis* (Nutt.) Nutt. | Utah Serviceberry |
| *Artemisia tridentata* Nutt. | Big Sage |
| *Atriplex confertifolia* (Torr. & Frem.) S. Wats. | Shadscale |
| *Cercocarpus ledifolius* Nutt. | Curlleaf Mountain Mahogany |
| *Chrysothamnus viscidiflorus* (Hook.) Nutt. | Douglas or Yellowbrush Rabbitbrush |
| *Ephedra viridis* (Cov.) | Green Ephedra, Mormon Tea, Joint Fir |
| *Gutierrezia sarothrae* (Pursh) Britton | Broom Snakeweek |
| *Holodiscus dumosus* (Hook.) Heller | Bush Oceanspray |
| *Physocarpus malvaceus* (Green) Kuntze | Mallow Ninebark |
| *Rosa woodsii* Lindl. | Wild Rose |
| *Symphoricarpos oreophilus* A. Gray | Mountain Snowberry |
| **Grasses and Sedges (6)** | |
| *Agropyron spicatum* (Pursh) Scrib. & Smith | Bluebunch Wheatgrass |
| *Agropyron trachycaulum* (Link) Malte | Slender Wheatgrass |
| *Carex geyeri* Boott | Elk Sedge |
| *Oryzopsis hymenoides* (Roem. & Schult.) Ricker | Indian Ricegrass |
| *Poa pratensis* L. | Kentucky Bluegrass |
| *Poa secunda* Presl | Sandberg's Bluegrass |

**Table 3-10**

## Table 9-7 Continued
## SPECIES PRESENCE LIST: GRASSLAND-SHRUB COMMUNITY

| | Species | Common Name |
|---|---|---|
| | **Forbs (17)** | |
| | *Arabis drummondii* A. Gray | Drummond's Rock Cress |
| | *Aster chilensis* Nees | Aster |
| | Cirsium undulatum (Nutt.) Spreng | Wavyleaf Thistle |
| | *Coryphantha vivipara* Britton & Brown | Mammillaria |
| | *Cryotantha humilis* (Greene) Payson | Cryptantha, Dwarf Catseye |
| | *Eriogonum corymbosum* Benth. | Buckwheat |
| | *Galium multiflorum* Kellogg | Shrubby Bedstraw |
| | *Haplopappus nuttallii* Torr. & Gray | Golden Weed |
| | *Heuchera parvifolia* Nutt. | Common Alumroot |
| | *Hymenoxus richardsonii* (Hook.) Cockerell | Hymenoxys |
| **(a)** | *Lappula redoskii* (Hornem.) Greene | Stickweed |
| | *Lepidium montanum* Nutt. | Mountain Pepperweed |
| | *Penstemon humilis* Nutt. | Low Penstemon |
| | *Penstemon thompsoniae* (A. Gray) Rydb. | Thompson's Penstemon |
| | *Phlox hoodii* Rich. | Hood's Phlox |
| | *Sisymbrium linifolium* Nutt. | Tumblemustard |
| | *Stanleya pinnata* (Pursh) Britton | Desert Prince's Plume |

**(a)** *annual*

**Table 3-11**

**Table 9-8**

## GRASSLAND-SHRUB UNDERSTORY VEGETATION ANALYSIS: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 50 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Trees*** | | | | | | | | | |
| *Abies concolor* | 1.1 | 2 | 1 | 2.02 | 0.48 | 0.2 | 2.7 | 0.98 | 0.97 |
| *Juniperus scopulorum* | 0.8 | 2 | 1 | 1.47 | 0.48 | 0.2 | 2.15 | 0.78 | 0.71 |
| *Pseudotsuga menziesii* | 0.64 | 4 | 3 | 1.18 | 0.97 | 0.59 | 2.74 | 0.99 | 1.14 |
| Subtotal | 2.54 | 8.0 | 5 | 4.67 | 1.93 | 0.99 | 7.59 | 2.75 | 2.82 |
| **Shrubs** | | | | | | | | | |
| *Amelanchier utahensis* | 1.24 | 10.0 | 4 | 2.28 | 2.42 | 0.79 | 5.49 | 1.99 | 5.52 |
| *Artemisia tridentata* | 0.20 | 2.0 | 1 | 0.37 | 0.48 | 0.20 | 1.05 | 0.38 | 0.18 |
| *Atriplex confertifolia* | 4.93 | 32.0 | 14 | 9.06 | 7.73 | 2.77 | 19.56 | 7.10 | 70.03 |
| *Chrysothamnus viscidiflorus* | 1.60 | 14.0 | 8 | 2.94 | 3.38 | 1.58 | 9.90 | 2.87 | 9.94 |
| *Gutierresia sarothrae* | 0.51 | 14.0 | 26 | 0.94 | 3.38 | 5.14 | 9.46 | 3.43 | 3.18 |
| *Rosa woodsii* | 0.20 | 2.0 | 1 | 0.04 | 0.48 | 0.20 | 0.72 | 0.26 | 0.02 |
| Subtotal | 8.68 | 74.0 | 54 | 15.63 | 17.87 | 10.68 | 46.18 | 16.03 | 88.87 |
| **Grasses and Sedges** | | | | | | | | | |
| *Agropyron spicatum* | 0.2 | 4 | 2 | 0.37 | 0.97 | 0.4 | 1.74 | 0.63 | 0.36 |
| *Agropyron trachycaulum* | 31.18 | 100 | 251 | 57.28 | 24.15 | 49.6 | 131.03 | 47.57 | 1383.31 |
| *Carex gyeri* | 0.3 | 4 | 3 | 0.55 | 0.97 | 0.59 | 2.11 | 0.77 | 0.53 |
| *Orysopsis hymenoides* | 0.1 | 2 | 1 | 0.18 | 0.48 | 0.2 | 0.86 | 0.31 | 0.09 |
| *Poa pratensis* | 0.04 | 2 | 1 | 0.07 | 0.48 | 0.2 | 0.75 | 0.27 | 0.03 |
| *Poa secunda* | 1.54 | 14 | 16 | 2.83 | 3.38 | 3.16 | 9.37 | 3.40 | 9.57 |
| Subtotal | 33.36 | 126 | 274 | 61.28 | 30.43 | 54.15 | 144.12 | 52.95 | 1393.89 |

** Understory data measured by quadrats*

**Table 3-11**

**Table 9-8 Continued**

**GRASSLAND-SHRUB UNDERSTORY VEGETATION ANALYSIS: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS**

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 50 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Forbs** | | | | | | | | | |
| *Arabis drummondii* | 0.1 | 8 | 7 | 0.18 | 1.93 | 1.38 | 3.49 | 1.27 | 0.35 |
| *Aster chilensis* | 0.04 | 2 | 2 | 0.07 | 0.48 | 0.4 | 0.95 | 0.34 | 0.03 |
| *Cryptantha humilis* | 0.12 | 10 | 6 | 0.22 | 2.42 | 1.19 | 3.83 | 1.39 | 0.53 |
| *Cryptogramma stelleri* | 0.4 | 2 | 1 | 0.73 | 0.48 | 0.2 | 1.41 | 0.51 | 0.35 |
| *Erigeron engelmannii* | 1.3 | 14 | 13 | 2.39 | 3.38 | 2.57 | 8.34 | 3.03 | 8.08 |
| *Galium multiflorum* | 2.96 | 40 | 85 | 5.42 | 9.66 | 16.8 | 31.88 | 11.57 | 52.36 |
| *Haplopappus nuttallii* | 0.56 | 16 | 14 | 1.03 | 3.86 | 2.77 | 7.66 | 2.78 | 3.98 |
| *Hymenoxys richardsonii* | 0.2 | 4 | 4 | 0.37 | 0.97 | 0.79 | 2.13 | 0.77 | 0.36 |
| *Lepidium montanum* | 0.02 | 2 | 1 | 0.04 | 0.48 | 0.2 | 0.72 | 0.26 | 0.02 |
| *Phlox hoodii* | 0.52 | 18 | 25 | 0.96 | 4.35 | 4.94 | 10.25 | 3.72 | 4.18 |
| *Penstemon hmilis* | 0.02 | 2 | 1 | 0.04 | 0.48 | 0.2 | 0.72 | 0.26 | 0.02 |
| *Sisymbrium linifolium* | 0.13 | 10 | 12 | 0.24 | 2.42 | 2.37 | 4.85 | 1.76 | 0.58 |
| *Stanleya pinnata* | 0.12 | 4 | 2 | 0.22 | 0.97 | 0.4 | 1.59 | 0.58 | 0.21 |
| Subtotal | 6.49 | 132 | 173 | 11.91 | 31.88 | 34.21 | 77.82 | 28.24 | 71.05 |

## Table 3-11

## Table 9-8 Continued

## GRASSLAND-SHRUB UNDERSTORY VEGETATION ANALYSIS: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 50 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Cryptogams** | | | | | | | | | |
| Moss | 0.44 | 16 | | 0.81 | 3.86 | | 4.67 | | |
| Lichens | 3.1 | 58 | | 5.7 | 14.01 | | 19.71 | | |
| Subtotal | 3.54 | 74 | | 6.51 | 17.87 | | 24.38 | | |
| Total: Living Plants | 54.61 | 414.00 | 506 | 100.00 | 99.98 | 100.03 | | | |
| Non-Living Cover | | | | | | | | | |
| Litter | 8.72 | | | | | | | | |
| Rock | 20.46 | | | | | | | | |
| Soil | 16.39 | | | | | | | | |

Table 3-12

## Table 9-9
## SPECIES PRESENCE LIST: CONIFER PLANT COMMUNITY

| Species (Total = 42) | Common Name |
|---|---|
| **Trees (6)** | |
| *Abies concolor* (gord. & Glend.) Lindl. | White Fir |
| *Acer glabrum* Torr. | Rocky Mountain Maple, Smooth Maple |
| *Juniperus scopulorum* Sarg. | Rocky Mountain Juniper |
| *Pinus edulis* Engelm. | Pinyon Pine |
| *Pinus flexilis* James | Limber Pine |
| Pseudotsuga menziesii (Mirb.) Franco | Douglas Fir |
| **Shrubs (9)** | |
| *Amelanchier utahensis* (Nutt.) Nutt. | Utah Serviceberry |
| *Artemisia tridentata* Nutt. | Big Sage |
| *Cercocarpus ledifolius* Nutt. | Curlleaf Mountain Mahogany |
| *Chrysothamnus viscidiflorus* (Hook.) Nutt. | Douglas or Yellowbrush Rabbitbrush |
| *Holodiscus dumosus* (Hook.) Heller | Bush Oceanspray |
| *Mahonia repens* G. Don | Oregon Grap, Creeping Barberry |
| *Physocarpus malvaceus* (Green) Kuntze | Mallow Ninebark |
| *Ribes cereum* Dougl. | Wax Currant |
| *Symphoricarpos oreophilus* A. Gray | Mountain Snowberry |
| **Grasses and Sedges (6)** | |
| *Agropyron trachycaulum* (Link) Malte | Slender Wheatgrass |
| *Carex geyeri* Boott | Elk Sedge |
| *Dactylis glomeratat* L. | Orcharg Grass |
| *Elymus glauca* Buckl. | Blue Wildrye |
| *Elymus salina* E. Jones | Salina Wildrye |
| *Poa secunda* Presl | Sandberg's Bluegrass |

**Table 3-12**

## Table 9-9 Continued
## SPECIES PRESENCE LIST: GRASSLAND-SHRUB COMMUNITY

| Species | Common Name |
|---|---|
| **Forbs (22)** | |
| *Antennaria parvifloia* Nutt. | Pussytoes, Everlasting |
| *Arabis drummondii* A. Gray | Drummond's Rock Cress |
| *Arabis pendulina* Greede | Rockcress |
| *Arabis pulchra* M.E. Jones | Rockcress |
| *Aster chilensis* Nees | Aster |
| *Castilleja linariaefolia* Benth. | Wyoming Painted Cup, Indian Paintbrush |
| *Chamaechaemactis scaposa* (Eastw.) Rydb. | False Yarrow |
| *Clematis pseudoalpina* (Kuntze) A. Nels. | Buckwheat |
| *Cryptantha Humilis* (Green) Payson | Cryptantha, Dwarf Catseye |
| *Erigeron engelmannii* A. Nels. | Englmann's Fleabane |
| *Erysimun Wheeleri* (Rothr.) Rydb. | Wallflower |
| *Galium multiflorum* Kellogg | Shrubby Bedstraw |
| *Haplopappus nuttallii* Torr. & Gray | Golden Weed |
| *Heuchera parvifolia* Nutt. | Common Alumroot |
| *Hymenoxus acaulis* (Pursh) Parker | Hymenoxys |
| *Malcolmia africana* (L.) R. Br. | African Mustard |
| *Pestemon eatoni* A. Gray | Eaton's Penstemon |
| *Penstemon thompsoniae* (A. Gray) Rydb. | Thompson's Penstemon |
| *Phlox hoodii* Rich. | Hood's Phlox |
| *Senecio multilobatus* Torr. & Gray | Lobeleaf Groundsel |
| *Sisymbrium altissimum* L. | Tumblemustard |
| *Stellaria jamesiana* Torr. | Tuber Starwort |

## Table 3-13
### Table 9-10
### CONIFER COMMUNITY TREE DATA

| Species | No. of Individuals | Density Trees/Acre | Relative % Density | Basal Area ($in^2$) | Relative % Dominance | % Cover | Relative % Cover | % Frequency | % ΣF | Importance Value | Relative Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trees** | | | | | | | | | | | | |
| *Abies Concolor* | 16 | 29.5 | 40 | 843.52 | 35.41 | 34.6 | 57.4 | 80 | 36.4 | 169.2 | 42.3 | 2089.4 |
| Juniperus scopulorum | 1 | 1.8 | 2.5 | 23.75 | 1 | 2.2 | 3.6 | 10 | 4.5 | 11.5 | 2.9 | 16.2 |
| Pinus edulis | 7 | 12.9 | 17.5 | 380.88 | 15.99 | 0 | 0 | 40 | 18.2 | 51.7 | 12.9 | 0 |
| *Pinus flexilis* | | | | | | 3.4 | 5.6 | | 0 | 5.6 | 1.4 | 0 |
| *Pseudotsuga mensiesii* | 16 | 29.5 | 40 | 1133.98 | 47.6 | 20.2 | 33.4 | 90 | 40.9 | 161.9 | 40.5 | 1366.1 |
| Totals | 40 | 73.7 | 100 | 2382.13 | 100 | 60.4 | 100 | 220 | 100 | 399.9 | 100 | 3471.7 |
| **Saplings and Seedlings** | | | | | | | | | | | | |
| *Abies Concolor* | 10 | 125.9 | 25 | | | | | 70 | 26.9 | 51.9 | | |
| Juniperus scopulorum | 7 | 90.7 | 18 | | | | | 60 | 23.1 | 41.1 | | |
| Pinus edulis | 2 | 25.2 | 5 | | | | | 10 | 3.8 | 8.8 | | |
| *Pinus flexilis* | 2 | 25.2 | 5 | | | | | 20 | 7.7 | 12.7 | | |
| *Pseudotsuga mensiesii* | 19 | 236.7 | 47 | | | | | 100 | 38.5 | 85.5 | | |
| Totals | 40 | 503.7 | 100 | | | | | 260 | 100 | 200 | | |
| **Trees plus Saplings and Seedlings** | | | | | | | | | | | | |
| *Abies Concolor* | 26 | 155.4 | 32.5 | | | | | | | | | |
| Juniperus scopulorum | 8 | 92.5 | 10 | | | | | | | | | |
| Pinus edulis | 9 | 38.1 | 11.3 | | | | | | | | | |
| *Pinus flexilis* | 2 | 25.2 | 2.5 | | | | | | | | | |
| *Pseudotsuga mensiesii* | 35 | 266.2 | 43.8 | | | | | | | | | |
| Totals | 80 | 577.4 | 100.1 | | | | | | | | | |

Table 3-14

Table 9-11

## CONIFER UNDERSTORY VEGETATION DATA: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 30 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Trees*** | | | | | | | | | |
| *Abies concolor* | 0.7 | 16.6 | 2 | 3 | 3.39 | 0.15 | 6.54 | 2.18 | 10.17 |
| *Juniperus scopulorum* | 0.76 | 16.6 | 5 | 3.31 | 3.39 | 0.38 | 7.08 | 2.36 | 11.22 |
| *Pinus flexilis* | 2 | 3.3 | 2 | 8.72 | 0.67 | 0.15 | 9.564 | 3.18 | 5.84 |
| *Pseudotsuga menziesii* | 2.73 | 10.6 | 3 | 11.9 | 2.16 | 0.23 | 4.29 | 4.76 | 25.7 |
| Subtotal | 6.19 | 47.1 | 12 | 26.93 | 9.61 | 0.91 | 27.47 | 12.48 | 52.93 |
| **Shrubs** | | | | | | | | | |
| *Amelanchier utahensis* | 2.35 | 16.6 | 4 | 10.24 | 3.39 | 0.30 | 13.93 | 4.64 | 34.71 |
| *Chrysothamnus viscidiflorus* | 0.03 | 3.3 | 1 | 0.13 | 0.67 | 0.08 | 0.88 | 0.29 | 0.09 |
| *Mahonia repens* | 1.30 | 20.0 | 66 | 5.67 | 4.08 | 4.95 | 14.70 | 4.90 | 23.13 |
| *Symphoricarpos oreophilus* | 0.13 | 6.7 | 2 | 0.57 | 1.37 | 0.15 | 2.09 | 0.70 | 0.78 |
| Subtotal | 3.81 | | 73 | 16.61 | 9.51 | 5.48 | 31.60 | 10.53 | 58.71 |
| **Grasses and Sedges** | | | | | | | | | |
| *Agropyron trachycaulum* | 6.27 | 80 | 833 | 27.33 | 16.32 | 62.54 | 106.19 | 35.4 | 446.03 |
| *Carex geyeri* | 1.18 | 33.3 | 37 | 5.14 | 6.79 | 2.78 | 14.71 | 4.9 | 34.9 |
| *Dactylis glomerata* | 0.23 | 10 | 7 | 1 | 2.04 | 0.53 | 3.57 | 1.19 | 2.04 |
| *Elymus glauoa* | 1.13 | 33.3 | 128 | 4.93 | 6.79 | 9.61 | 21.33 | 7.11 | 33.47 |
| *Elymus salina* | 0.2 | 6.7 | 5 | 0.87 | 1.37 | 0.38 | 2.62 | 0.87 | 1.19 |
| Subtotal | 9.01 | 163.3 | 1,010 | 39.27 | 33.31 | 75.84 | 42.23 | 49.47 | 517.63 |

** Understory data measured by quadrats. See Tree Tables for canopy data measured by point-quarter and line intercept method.*

Table 3-14

Table 9-11 Continued

CONIFER UNDERSTORY VEGETATION DATA: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 30 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Forbs** | | | | | | | | | |
| *Castilleja linariaefolia* | 0.01 | 6.7 | 2 | 0.04 | 1.37 | 0.15 | 1.51 | 0.5 | 0.05 |
| *Chamaechaenactis scaposa* | 0.1 | 3.3 | 2 | 0.44 | 0.67 | 0.15 | 1.26 | 0.42 | 0.29 |
| *Cryptantha humilis* | 0.01 | 3.3 | 1 | 0.04 | 0.67 | 0.08 | 0.79 | 0.26 | 0.03 |
| *Erigeron engelmannii* | 0.12 | 3.3 | 3 | 0.52 | 0.67 | 0.23 | 1.42 | 0.47 | 0.35 |
| *galium multiflorum* | 1.44 | 60 | 130 | 6.28 | 12.24 | 9.76 | 28.28 | 9.43 | 76.87 |
| *Haplopappus nuttallii* | 0.03 | 3.3 | 1 | 0.13 | 0.67 | 0.08 | 0.88 | 0.29 | 0.09 |
| *Hemenoxys acaulis* | 0.44 | 10 | 6 | 1.92 | 2.04 | 0.45 | 4.41 | 1.47 | 3.92 |
| *Malcolimia africana* | 0.01 | 3.3 | 2 | 0.04 | 0.67 | 0.15 | 0.86 | 0.29 | 0.03 |
| *Penstemon thompsoniae* | 0.05 | 13.3 | 6 | 0.22 | 2.71 | 0.45 | 3.38 | 1.13 | 0.6 |
| *Phlox hoodii* | 1.28 | 80 | 76 | 5.58 | 16.32 | 5.26 | 27.16 | 9.06 | 91.07 |
| *Senecio multilobatus* | 0.27 | 13.3 | 10 | 1.18 | 2.71 | 0.75 | 4.64 | 1.55 | 3.2 |
| *Sisymbrium altissimum* | 0.01 | 3.3 | 1 | 0.04 | 0.67 | 0.08 | 0.79 | 0.26 | 0.03 |
| *Stellaria jamesiana* | 0.01 | 10 | 3 | 0.04 | 2.04 | 0.23 | 2.31 | 0.77 | 0.08 |
| Subtotal | 3.78 | 213.1 | 243 | 16.47 | 43.45 | 17.82 | 77.69 | 25.9 | 176.61 |

## Table 3-14

## Table 9-11 Continued

## CONIFER UNDERSTORY VEGETATION DATA: COVER FREQUENCY, AND DENSITY DATA FROM QUADRATS

| Species | Average % Cover per Quadrat | Absolute Frequency | Number of Stems in 30 Quadrats | Relative % of Cover | % ΣF | % Density | Importance Value | % Importance | C x F Index |
|---|---|---|---|---|---|---|---|---|---|
| **Cryptogams** | | | | | | | | | |
| Moss | 0.07 | 10 | | 0.35 | 2.04 | | 2.39 | 0.8 | 0.71 |
| Lichens | 0.08 | 10 | | 0.35 | 2.04 | | 2.39 | 0.8 | 0.71 |
| Subtotal | 0.15 | 20 | | 0.7 | 4.08 | | 4.78 | 1.6 | 1.42 |
| Total: Living Plants | 19.17 | 443.50 | 1,338 | 99.98 | 99.96 | 100.05 | 183.77 | 99.98 | 807.30 |
| Non-Living Cover | | | | | | | | | |
| Litter | 23.37 | | | | | | | | |
| Rock | 19.23 | | | | | | | | |
| Soil | 34.4 | | | | | | | | |
| Total | 77 | | | | | | | | |

Table 3-15

Table 9-12

## VEGETATIVE PRODUCTIVITY IN THE RAPARIAN PLANT COMMUNITY, TRAIL MOUNTAIN MIN PLAN AREA, JULY 18, 1981

(Table entries are grams/$M^2$)

| Sample Number | TREES | | SHRUBS | | GRASSES | | FORBS | | ANNUALS | | TOTALS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fresh Weight | Air Dry | Fresh Weight | Air Dry | Fresh Weight | Air Dry | Fresh Weight | Air Dry | Fresh Weight | Air Dry | Fresh Weight | Air Dry |
| 1 | 33 | 13 | 18 | 15 | 124 | 53 | 188 | 64 | 0 | 0 | 363 | 145 |
| 2 | 90 | 35 | 4 | 1 | 244 | 99 | 116 | 30 | 0 | 0 | 454 | 165 |
| 3 | 0 | 0 | 16 | 6 | 336 | 125 | 220 | 48 | 0 | 0 | 572 | 179 |
| 4 | 0 | 0 | 220 | 92 | 100 | 41 | 272 | 77 | 0 | 0 | 592 | 210 |
| 5 | 0 | 0 | 180 | 75 | 8 | 3 | 80 | 23 | 0 | 0 | 268 | 101 |
| 6 | 0 | 0 | 0 | 0 | 280 | 114 | 420 | 119 | 0 | 0 | 700 | 234 |
| 7 | 38 | 15 | 0 | 0 | 220 | 90 | 260 | 74 | 0 | 0 | 518 | 178 |
| 8 | 0 | 0 | 600 | 250 | 8 | 3 | 6 | 2 | 0 | 0 | 614 | 255 |
| 9 | 0 | 0 | 108 | 32 | 148 | 63 | 140 | 44 | 0 | 0 | 396 | 140 |
| 10 | 0 | 0 | 120 | 50 | 44 | 18 | 104 | 30 | 0 | 0 | 268 | 98 |
| Averages (g/$M^2$) | 16 | 6 | 127 | 52 | 151 | 61 | 181 | 51 | 0 | 0 | 475 | 170 |
| Lb./Acre | 143 | 54 | 1,132 | 464 | 1,346 | 544 | 1,614 | 455 | 0 | 0 | 4,236 | 1,516 |
| Percent of Total | 3 | 4 | 27 | 31 | 32 | 36 | 38 | 30 | 0 | 0 | 100 | 100 |

Table 3-16

Table 9-13

## VEGETATIVE PRODUCTIVITY IN THE GRASSLAND-SHRUB COMMUNITY, TRAIL MOUNTAIN MIN PLAN AREA, JULY 18, 1981

(Table entries are grams/$M^2$)

| Sample Number | TREES | | SHRUBS | | GRASSES | | FORBS | | ANNUALS | | TOTALS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fresh Weight | Air Dry | Fresh Weight | Air Dry | Fresh Weight | Air Dry | Fresh Weight | Air Dry | Fresh Weight | Air Dry | Fresh Weight | Air Dry |
| 1 | 0 | 0 | 22 | 11 | 188 | 105 | 68 | 32 | 0 | 0 | 278 | 148 |
| 2 | 0 | 0 | 6 | 4 | 138 | 75 | 6 | 2 | 0 | 0 | 150 | 81 |
| 3 | 0 | 0 | 35 | 18 | 100 | 54 | 0 | 0 | 0 | 0 | 135 | 72 |
| 4 | 0 | 0 | 0 | 0 | 168 | 91 | 2 | 1 | 0 | 0 | 170 | 92 |
| 5 | 0 | 0 | 3 | 2 | 30 | 16 | 45 | 17 | 0 | 0 | 78 | 35 |
| 6 | 0 | 0 | 3 | 1 | 230 | 125 | 42 | 16 | 0 | 0 | 275 | 142 |
| 7 | 0 | 0 | 71 | 36 | 190 | 103 | 34 | 13 | 0 | 0 | 295 | 152 |
| 8 | 0 | 0 | 0 | 0 | 210 | 114 | 10 | 4 | 0 | 0 | 220 | 118 |
| 9 | 0 | 0 | 23 | 7 | 176 | 92 | 24 | 7 | 0 | 0 | 223 | 106 |
| 10 | 0 | 0 | 18 | 9 | 56 | 30 | 95 | 36 | 0 | 0 | 169 | 75 |
| Averages (g/$M^2$) | 0 | 0 | 18 | 9 | 149 | 81 | 33 | 13 | 0 | 0 | 199 | 102 |
| Lb./Acre | 0 | 0 | 161 | 80 | 1,329 | 722 | 294 | 116 | 0 | 0 | 1,774 | 910 |
| Percent of Total | 0 | 0 | 9 | 9 | 75 | 79 | 17 | 1 | 0 | 0 | 100 | 100 |

Table 3-17

# Table 9-14
# VEGETATION SAMPLING PRECISION

A. Number of Sampling Units Required for 20% Precision at the 80 % Confidence Level.

| | Community | | | |
|---|---|---|---|---|
| | Riparian | Pinyon-Juniper | Grassland-Shrub | Conifer |
| Tree DBH, Basal Area, Dominance | 13 | 9 | - | 8 |
| Tree Density | 33 | 6 | - | 19 |
| Sapling Density | 22 | 19 | - | 22 |
| Canopy Cover (Tree) | 24 | 97 | - | 37 |
| Understory Cover | | | | |
| Total Living Plants | 8 | 22 | 9 | 30 |
| Dominant Life Form* | 19 (f) | 49 (g) | 13 (g) | 39 (g) |
| Non-Living Total (litter, rock, soil) | 3 | 2 | 11 | 3 |
| Dominant Non-Living Category** | 10 (L) | 20 (R) | 40 (S) | 17 (S) |
| Understory Vegetation Density | | | | |
| Total Living Plants | 10 | 73 | 11 | 36 |
| Dominant Life Form* | 16 (f) | 85 (g) | 11 (g) | 68 (g) |

B. Actual Precision Obtained at 80% Confidence Level.

| | Community | | | |
|---|---|---|---|---|
| | Riparian | Pinyon-Juniper | Grassland-Shrub | Conifer |
| Tree DBH, Basal Area, Dominance | ± 11% | ± 9% | - | ± 9% |
| Tree Density | ± 18% | ± 7% | - | ± 13% |
| Sapling Density | ± 15% | ± 13% | - | ± 15% |
| Canopy Cover (Tree) | ± 22% | ± 44% | - | ± 27% |
| Understory Cover | | | | |
| Total Living Plants | ± 10% | ± 13% | ± 9% | ± 20% |
| Dominant Life Form* | ± 16% (f) | ± 19% (g) | ± 10% (g) | ± 22% (g) |
| Non-Living Total (litter, rock, soil) | ± 5% | ± 4% | ± 9% | ± 5% |
| Dominant Non-Living Category** | ± 11% (L) | ± 12% (R) | ± 18% (S) | ± 15% (S) |
| Understory Vegetation Density | | | | |
| Total Living Plants | ± 12% | ± 24% | ± 9% | ± 22% |
| Dominant Life Form* | ± 15% (f) | ± 26% (g) | ± 9% (g) | ± 30% (g) |

* t = trees, s = shrubs, g = grasses, f = forbs, c = cryptograms
** L = litter, R = rock, S = soil

**Table 3-18**

**Table 10-1**

## List of Macroinvertebrates Found in Cottonwood Creek Above Trail Mountain Mine Site.

| Taxonomic Rank | Relative Abundance | Indicator of good stream condition |
|---|---|---|
| Class Turbellaria | | |
| Order Tricladida | A | |
| Class Crustacea | | |
| Order Ostracoda | U | |
| Class Insecta | | |
| Order Ephemeroptera | | |
| Family Baetidae | | |
| Baetis | A | |
| Family Heptageniidae | | |
| Cinygmula | C | X |
| Family Ephemerellidae | | |
| Cphemerella grandis | C | X |
| Order Plecoptera | | |
| Family Nemouridae | | |
| Ampinemira | C | X |
| Family Perlodidae | | |
| Isoperla | C | X |
| Order Trichoptera | | |
| Family Hydropsychidae | | |
| Hydropsyche | A | |
| Family Limnephilidae | | |
| Hesperophylax | C | |
| Family Brachycentrus | | |
| Brachycentrus | A | |
| Order Cloeoptera | | |
| Family Elmidae | U | |
| Order Diptera | | |
| Family Tipulidae | | |
| Antocha monticola | C | |
| Dicranota | U | |
| Holorusia grandis | C | |
| Eriocera | U | |
| Family Pshchodidae | | |
| Pericoma | U | |
| Family Chironomidae | U | |
| Family Empididae | | |
| Hemerodromia | U | |

A = Abundant - greater than 100/$m^2$
C = Common - Between 99 and 10/$m^2$
U = Uncommon - Less than 10/$m^2$

**Table 3-19**

**Table 10-2**

## List of Macroinvertebrates Found in Cottonwood Creek Below Trail Mountain Mine Site.

| Taxonomic Rank | Relative Abundance | Indicator of good stream condition |
|---|---|---|
| Class Oligochaeta | U | |
| Class Arachnida | | |
| Order Hydracarina | C | |
| Class Insecta | | |
| Order Ephemeroptera | | |
| Family Baetidae | | |
| Baetis | A | |
| Family Heptageniidae | | |
| Cinygmula | C | X |
| Order Plecoptera | | |
| Family Perlodidae | | |
| Isogenoides ziinensis | U | |
| Isoperla | U | X |
| Order Trichoptera | | |
| Family Hydropsychidae | | |
| Hydropsyche | U | |
| Order Cloeoptera | | |
| Family Dytiscidae | U | |
| Family Elmidae | U | |
| Order Diptera | | |
| Family Simuliidae | U | |
| Family Chironomidae | U | |

A = Abundant - greater than 100/$m^2$
C = Common - Between 99 and 10/$m^2$
U = Uncommon - Less than 10/$m^2$

**Table 3-20**

**Table 10-3**

## Species List and Classification of Mammals whose Published Ranges Overlap the Area Studied for the Trail Mountain Mine

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Masked Shrew<br>Sorex cinereus | | | | | UR | | |
| Mirriam Shrew<br>Sorex mirriami | UR | UR | UR | | UR | | |
| Dusky Shrew<br>Sorex obscurus | | | | | UR | | |
| Little Brown Myotis<br>Myotis licifugus | CS | US | CS | | CS | | |
| Fringed Myotis<br>Myotis thysanodes | US | US | | | | | |
| California Myotis<br>Myotis californicus | US | US | US | | | | |
| Small-Footed Myotis<br>Myotis leibii | | US | US | | US | | |
| Silver-Haired Bat<br>Lasionycteris noctivagans | | | | | US | | |
| Big Brown Bat<br>Eptesicus fuscus | | | | | US | | |
| Hoary Bat<br>Lasiurus cinereus | | | | | US | | |
| Townsend's Big-Eared Bat<br>Plecotus townsendii | US | US | | | US | | |
| Brasilian Free-Tailed Bat<br>Tadarida brasiliensis | US | US | US | | US | | |
| Nuttall's Cottontail<br>Sylvilagus nuttallii | UR | | UR | | UR | | X |
| Desert Cottontail<br>Sylvilagus audubonii | UR | | | | | | X |
| Snowshoe Hare<br>Lepus americanus | | CR | | CR | | | X |
| White-Tailed Jackrabbit<br>Lepus townsendii | | UR | UR | | UR | | X |

## Table 3-20

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Black-Tailed Jackrabbit<br>Lepus californicus | CR | | | | | | X |
| Least Chipmunk<br>Eutamias minimus | AR | UR | | CR | CR | X | |
| Cliff Chipmunk<br>Neotamias dorsalis | | | CR | | | X | |
| Unita Chipmunk<br>Neotamias umbrinus | CR | CR | | | CR | X | |
| Yellow-Billied Marmot<br>Marmota flaviventris | | CR | CR | | CR | X | |
| White-Tailed Antelope Squirrel<br>Ammospermophilus leucurus | | CR | | | | X | |
| Uinta Ground Squirrel<br>Spermophilus armatus | | AR | | | AR | X | |
| Golden-Manteled Ground Squirrel<br>Spermophidus lateralis | | UR | | | UR | X | |
| Rock Squirrel<br>Spermophilus varegatus | | | | | CR | X | |
| Red Squirrel<br>Tamiasciurus hudsonicus | | | | CR | | X | |
| Northern Flying Squirrel<br>Glaucomys sabrinus | | UR | | | CR | | |
| Northern Pocket Gopher<br>Thomomys talpoides | | CR | | | | X | |
| Great Basin Pocket Mouse<br>Perognathus parvus | UR | | | | UR | X | |
| Western Harvest Mouse<br>Reithrodontomys megalotis | UR | UR | | | UR | X | |
| Deer Mouse<br>Peromyscus maniculatus | AR | AR | AR | AR | AR | X | |
| Pinyon Mouse<br>Peromyscus truei | CR | | | | | X | |
| Desert Woodrat<br>Neotoma lepids | CR | | | | | | |
| Bushy-Tailed Woodrad<br>Neotoma cinerea | | | CR | | CR | | |

## Table 3-20

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Montane Vole<br>Microtus montanus | | | | CR | CR | | |
| Porcupine<br>Erethizon dorsatum | CR | | | CR | CR | X | |
| Coyote<br>Canis latrans | CR | CR | CR | CR | CR | | X |
| Red Fox<br>Vulpes fulva | CaR | | | | CaR | | X |
| Gray Fox<br>Urocyon cinereoargenteus | | | UR | | UR | | X |
| Black Bear<br>Ursus americanus | | | | CaR | CR | | X |
| Ringtail<br>Bassariscus astutus | UR | | UR | | UR | | |
| Raccoon<br>Procyon lotor | Ca | | | | Ca | | |
| Marten<br>Martes americana | | | | CaR | | | X |
| Ermine or Short-Tailed Weasel<br>Mustels erminea | | UR | | UR | | | |
| Long-Tailed Weasel<br>Mustela frenata | CR | CR | CR | CR | CR | | X |
| Badger<br>Taxidea taxus | CR | CR | | CR | CR | X | X |
| Striped Skunk<br>Mephitis mephitis | CR | CR | CR | CR | CR | X | X |
| Mountain Lion<br>Felis concolor | UR | UR | UR | UR | UR | | X |
| Bobcat<br>Lynx rufus | CR | CR | CR | CR | CR | | X |
| Wapiti or Elk<br>Cervus elaphus | | | | | CW | X | X |
| Mule Deer<br>Odocoileus hemionus | CR | CR | CR | CR | CR | X | X |
| Moose<br>Alces alces | | CaR | | CaR | | | X |

**Table 3-21**

**Table 10-4**

## Species List and Classification of Birds whose Published Ranges Overlap the Area Studied for the Trail Mountain Mine

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Turkey Vulture<br>Cathartes aura | | US | US | | | | X |
| Goshowk<br>Accipiter gentilis | | CR | | CR | | X | X |
| Sharp-Shinned Bawk<br>Accipiter Striatus | | US | | US | | | X |
| Coopers Hawk<br>Accipiter cooperii | | US | | US | | | X |
| Red-Tailed Hawk<br>Buteo jamaicens | | CR | | | | | X |
| Swainson's Hawk<br>Buteo swainsoni | | US | | | | | X |
| Rough-Legged Hawk<br>Buteo lagopus | | UW | | | | | X |
| Golden Eagle<br>Aquila chrysaetos | | CR | CR | CR | CR | X | X |
| Bald Eagle<br>Haliaeetas leucocephalus | UW | | | | | | |
| Prairie Falcon<br>Falco mjexicanus | UR | UR | | | | | X |
| Peregrine Falcon<br>Falco peregrinus | | CaR | | | | | |
| Merlin<br>Falco columbarius | CaW | | | | | | X |
| American Kestrel<br>Falco sparverius | CS | CS | CS | | CS | X | X |
| Ferruginous Hawk<br>Buteo regalis | | US | | US | | | X |
| Blue Grouse<br>Dendragapus obscurus | | UR | | CR | UR | | X |
| Ruffed Grouse<br>Bonass umbellus | | CR | | CR | CR | | X |

## Table 3-21

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Chukar<br>Alectoris chucker | UR | | | | | | X |
| Band-Tailed Pegeon<br>Columba fasciata | | CaS | | | CaS | | |
| Mourning Dove<br>Zenaidura macroura | CS | CS | | | CS | X | X |
| Yellow-Billed Cuckoo<br>Coccyzus americanus | | | | | CaS | | |
| Screech Owl<br>Otus asio | | | | | UR | | X |
| Flammulated Owl<br>Otus flammeolus | | UR | | UR | | | X |
| Great Horned Owl<br>Bubo virginiaus | CR | CR | CR | UR | CR | | X |
| Pygmy Owl<br>Glaucidium gnoma | | UR | UR | | UR | | X |
| Spotted Owl<br>Strix occidentalis | | | | | UR | | X |
| Long-Eared Owl<br>Asio otus | | | | | CR | | X |
| Short-Eared Owl<br>Asio flammeus | | CR | | | | | X |
| Saw-Whet Owl<br>Aegolius accdicus | | UR | | UR | UR | | X |
| Poor-Will<br>Phalaenoptilus nuttallii | | | | | CS | | |
| Common Nighthawk<br>Chordeiles minor | CS | CR | | | CS | | |
| Black Swift<br>Cypseloides niger | | | CaS | | | | |
| White-Throated Swift<br>Aerohautes saxatalis | | | US | | | | |
| Black-Chinned Hummingbird<br>Archilochus alexandri | | US | | | US | | |
| Broadtailed Hummingbird<br>Selasphorus platycercus | CS | CS | | CS | CS | X | |

## Table 3-21

A = Abundant
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Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Rufous Hummingbird<br>Selasphorus rufus | | CS | | CS | CS | | |
| Calliope Hummingbird<br>Stellula callipe | | CaS | | CaS | CaS | | |
| Belted Kingfisher<br>Megaceryle alcyon | CaS | | | | | | |
| Common Flicker<br>Colaptes cafer | | CR | | CR | CR | X | |
| Lewis' Woodpecker<br>Melanerpes lewis | | | | | CaS | | |
| Yellow-Bellied Sapsucker<br>Sphyrapicus varius | | CR | | CR | UR | | |
| Williamson's Sapsucker<br>Sphyrapicus thyroideus | | | | CaS | | | |
| Hairy Woodpecker<br>Dendrocopos villosus | | CR | | CR | CR | X | |
| Downy Woodpecker<br>Denrocopos pubescens | | | | | CR | X | |
| Northern Three-Toed Woodpecker<br>Picoides tridactylus | | | | CaR | | | |
| Eastern Kingbird<br>Tyrannus tyrannus | | | | | CS | | |
| Western Kingbird<br>Tyrannus verticalis | | US | | | CS | | |
| Willow (Traill's) Flycatcher<br>Empidonax traillii | | | | | CS | | |
| Hammonds Flycatcher<br>Epidonas hammondii | | | | US | | | |
| Dusky Flycatcher<br>Epidonax oberholseri | | | | | CS | | |
| Gray Flycatcher<br>Epidonax wrightii | CaS | | | | | | |
| Western Flycatcher<br>Epidonax difficilis | | CS | | CS | CS | | |
| Western Wood Pewee<br>Contopus sordidulus | | CS | | CS | CS | | |

## Table 3-21

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Olive-Sided Flycatcher<br>Nuttallornis borealis | | US | | US | US | | |
| Violet-Green Swallow<br>Tachycineta thalassina | US | | | | | X | |
| Tree Swallow<br>Iridoprocne bicolor | US | | | | | X | |
| Barn Swallow<br>Hirundo rustica | | | CS | | | | |
| Cliff Swallow<br>Petrochelidon pyrrhonota | | | CS | | | | |
| Purple Martin<br>Progne subis | | US | | US | | | |
| Gray Jay<br>Perisoreus canadenis | | | | CS | | X | |
| Steller's Jay<br>Cyanocitta stelleri | CR | CR | | CR | | X | |
| Scrub Jay<br>Aphelocoma coerulescens | | | | | CR | X | |
| Black-Billed Magpie<br>Pica pica | CR | CR | | CR | CR | X | |
| Common Raven<br>Corvus coras | CR | | | | | X | |
| Pinon Jay<br>Gymnorhinus cyanocephala | CR | | | | CR | X | |
| Clark's Nutcracker<br>Nucifraga columbiana | | | | CR | | X | |
| Black-Capped Chickadee<br>Parus atricapillus | CR | CR | | CR | CR | X | |
| Mountain Chickadee<br>Parus gambelii | | | | CS | CW | X | |
| Juniper Titmouse<br>Baeolophus ridgwayi | UR | | | | UR | | |
| Common Bushtit<br>Psaltriparus minimus | UR | UR | | | UR | | |
| White-Breasted Nuthatch<br>Sitta carolinensis | UR | CR | UR | CR | | | |

## Table 3-21

A = Abundant
C = Common
U = Uncommon
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R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Red-Breasted Nuthatch<br>Sitta canadensis | | | CR | | | | |
| Brown Creeper<br>Certhia familiaris | CW | CS | | CS | CS | | |
| House Wren<br>Troglodytes aedon | | CS | | | CS | | |
| Rock Wren<br>Salpinctes obsoletus | | | CR | | | | |
| Catbird<br>Dumetella carolinensis | | | | | CS | X | |
| Sage Thrasher<br>Oreoscoptes monanus | | | | | CS | | |
| Robin<br>Turdus migratorius | CR | CS | | CR | CS | X | |
| Hermit Thrush<br>Catharus guttata | | CS | | | CS | | |
| Swainson's Thrush<br>Catharus ustulata | | CS | | US | CS | | |
| Veery<br>Catharus fuscescens | | | | | US | X | |
| Mountain Bluebird<br>Sialia currucoides | CS | | | | CS | X | |
| Townsend's Solitaire<br>Myadestes townsendi | | | | | CS | | |
| Blue-Gray Goatcatcher<br>Poioptila caerulea | CS | CS | | US | CS | | |
| Golden-Crowned Kinglet<br>Regulus satrapa | UW | | | US | UW | | |
| Ruby-Crowned Kinglet<br>Regulus calendula | | | | US | UW | | |
| Northern Shrike<br>Lanius excubitor | UW | | | | UW | | |
| Loggerhead Shrike<br>Lanius lodovicianus | CS | | | | | X | |
| Starling<br>Sturnus vulgaris | CR | | | | CR | X | |

## Table 3-21

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Solitary Vireo<br>Vireo solitarius | US | US | | | US | | |
| Warbling Vireo<br>Vireo gilvus | | CS | | | CS | X | |
| Orange-Crowned Warbler<br>Vermivora celata | | CS | | | CS | | |
| Virginia's Warbler<br>Vermivora virginiae | US | | | | CS | | |
| Yellow Warbler<br>Dendroica petechia | | CS | | | CS | X | |
| Audubon's Warbler<br>Dendroica auduboni | | | | | CS | X | |
| Black-Throated Gray Warbler<br>Dendroica nigrescens | CS | CS | | | CS | | |
| Mac Gillivray's Warbler<br>Oporornis tolmiei | | | | | CR | | |
| Yellowthroat Warbler<br>Geothlypis trichas | | | | | US | | |
| Yellow-Breasted Chat<br>Icteria verens | | | | | CS | X | |
| Wilson's Warbler<br>Wilsonia pusilla | | | | CS | CS | | |
| American Redstart<br>Setophaga ruticilla | | CaS | | | CaS | | |
| Western Medowlark<br>Sturnella neglecta | CR | | | | | X | |
| Bullock's Oriole<br>Icterus bullockii | | | | | US | | |
| Western Tanager<br>Piranga ludoviciana | | CS | | CS | | | |
| Black-Headed Grosbeak<br>Pheucticus melanocephalus | CS | CS | | CS | CS | | |
| Lazuli Bunting<br>Passerina amoena | | | | | CS | | |
| Evening Grosbeak<br>Hesperiphona vespertina | | | | | US | | |

## Table 3-21

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Cassin's Finch<br>Carpodacus cassinii | US | US | | US | | | |
| House Finch<br>Carpodacus mexicanus | | | | | US | | |
| Pine Grosbeak<br>Pinicola enucleator | | US | | US | | | |
| Black Rosey Finch<br>Leucosticte atrata | UW | | | | | | |
| Pine Siskin<br>Spinus pinus | | CS | | CS | | | |
| American Goldfinch<br>Spinus tristis | | | | | CS | | |
| Lesser Goldfinch<br>Spinus psaltria | | | | | US | | |
| Red Crossbill<br>Loxia curvirostra | | | | US | | | |
| Green-Tailed Towhee<br>Chlorura chlorura | US | | | | CS | X | |
| Rufous-Sided Towhee<br>Pipilo erythrophthalmus | | | | | US | | |
| Junco<br>Junco hyemalis | UW | CS | | CS | | X | |
| Tree Sparrow<br>Spizella arborea | | | | | UW | | |
| Chipping Sparrow<br>Spizella passerina | | CS | | CS | CS | X | |
| White-Crowned Sparrow<br>Zonotrichia leucophrys | | CS | | CS | | | |
| Fox Sparrow<br>Passerella iliaca | | | | | US | | |
| Song Sparrow<br>Melospiza melodia | | | | | US | | |

## Table 3-22

## Table 10-5

### Species List and Classification of Reptiles and Amphibians whose Published Ranges Overlap the Area Studied for the Trail Mountain Mine

A = Abundant
C = Common
U = Uncommon
Ca = Casual or Rare
R = Permanent Resident
S = Summer Only
W = Winter Only

| Species Name | Pinyon-Juniper | Grass-Aspen | Cliff | Mixed Conifer | Mixed Mtn. Shrub | Observed on Site | High-Interest Species |
|---|---|---|---|---|---|---|---|
| Fence Lizard<br>Sceloporus undulatus | US | | | | US | X | |
| Sagebrush Lizard<br>Sceloporus graciosus | CS | | CS | | CS | X | |
| Mountain Short-Horned Lizard<br>Phrynosoma douglassi | CS | CS | CS | | CS | | |
| Rocky Mountain Rubber Boa<br>Charina bottae | | | | | US | | |
| Wandering Garter Snake<br>Thamnophis elegans | CS | US | | | CS | X | |
| Western or Yellow-Bellied Racer<br>Coluber constrictor | US | | | | US | | |
| Striped Whipsnake<br>Masticophis taeniatus | US | | | | US | | |
| Gopher Snake<br>Pituophis melanoleucus | CS | | | | CS | | |
| Milk Snake<br>Lampropeltis triangulum | US | | | | US | | |
| Utah Mountain Kingsnake<br>Lampropeltis Pyromelana | US | | | | US | | |
| Night Snake<br>Hypsiglena torquata | | | | | US | | |
| Midget Faded Rattlesnake<br>Crotalus oreganus concolor | CS | US | | | US | | |
| Western Spadefoot Toad<br>Scaphiopus hammondi | | US | | | US | | |
| Woodhouse's Toad<br>Bufo woodhousei | | US | | | US | | |

Table 3-23

Table 10-6

## Game Animals in the Environs of Trail Mountain Mine in Emery County, Utah

Nuttall's Cottontail
Sylvilagus nuttallii

Desert Cottontail
Sylvilagus audubonii

Showshoe Hare
Lepus americanus

Black Bear
Ursus americanus

Mountain Lion
Felis concolor

Bobcat
Lynx rufus

Mule Deer
Odocoileus hemionus

Moose Alces alces

Wapiti or Rocky Mountain Elk
Cervus elaphus

Bandtail Pigeon
Columba fasciata

Mourning dove
Zenaidura macroura

Blue Grouse
Dendragapus obscurus

Ruffed Grouse
Bonasa umbellus

Chuckar
Alectoris chukar

Table 3-24

Table 10-7

## Endangered Species of the Environ of Trail Mountain Mine in Emery County, Utah

Bald Eagle*
Haliaeetus leucocephalus

Peregrine Falcon*
Falco peregrinus

* These species were endangered at the time this list was constructed. The Bald Eagle and Peregrine Falcon are no longer on the endangered species list. The Bald Eagle is now on the "Utah Species of Concern" list. The Peregrin Falcon has been delisted.

**Table 3-25**

**Table 10-8**

## Raptors of the Environ of Trail Mountain Mine in Emery County, Utah

Turkey Vulture
Cathartes aura

Goshawk
Accipiter gentilis

Sharp-Shinned Hawk
Accipiter striatus

Cooper's Hawk
Accipiter cooperii

Red-Tailed Hawk
Buteo jamaicensis

Swainson's Hawk
Buteo swainsoni

Rough-Legged Hawk
Buteo lagopus

Golden Eagle
Aquila chrysaetis

Bald Eagle
Haliaeetus leucocephalus

Prairie Falcon
Falcon mexicanus

Pregrine Falcon
Falco peregrinus

Merlin
Falco columberius

American Kestrel
Falco sparverius

Screech Owl
Otus asio

Flammulated Owl
Otus flammeolus

Great Horned Owl
Bubo virginianus

Ferruginous Hawk
Butes regalis

## Table 10-8 continued

Pygmy Owl
Cidium gnoma

Spotted Owl
Strix occidentalis

Long-Eared Owl
Asio otus

Short-Eared Owl
Asio flammeus

Saw-Whet Owl
Aegolius acadicus

**Table 3-26**

**Table 10-9**

## Projected Impact of the Trail Mountain Mine and Associated Facilities on High Interest Species of Taxonomic Grups Using a Perturbation Rating Scale of 0 to 10. (low to high).*

| | Perturbation Rating |
|---|---|
| **Birds** | |
| Turkey Vulture | 0 |
| Goshawk | 0 |
| Sharp-Shinned Hawk | 0 |
| Cooper's Hawk | 0 |
| Red-Tailed Hawk | 0 |
| Swainson's Hawk | 0 |
| Rough-Legged Hawk | 0 |
| Golden Eagle | 0 |
| Bald Eagle | 0 |
| Prairie Falcon | 0 |
| Pregrine Falcon | 0 |
| Merlin | 0 |
| American Kestrel | 1 |
| Blue Grouse | 0 |
| Ruffed Grouse | 0 |
| Chukar | 0 |
| Morning Dove | 1 |
| Screech Owl | 0 |
| Flammulated Owl | 0 |
| Great Horned Owl | 0 |
| Pygmy Owl | 0 |
| Spotted Owl | 0 |
| Long-Eared Owl | 0 |
| Short-Eared Owl | 0 |
| Saw-Whet Owl | 0 |
| **Mammals** | |
| Nuttall's Cottontail | 1 |
| Desert Cottontail | 0 |
| Snowshoe Hare | 0 |
| White-Tailed Jackrabbit | 0 |
| Black-Tailed Jackrabbit | 0 |
| Coyote | 0 |
| Red Fox | 0 |
| Gray Fox | 0 |
| Black Bear | 0 |
| Marten | 0 |

**Table 3-26**

## Table 10-9 Continued

| | |
|---|---|
| **Mammals Continued** | |
| Ermine | 0 |
| Long-Tailed Weasel | 0 |
| Badger | 0 |
| Striped Skunk | 0 |
| Mountain Lion (Cougar) | 1 |
| Bobcat | 1 |
| Mule Deer | 3 |
| Moose | 0 |
| Wapiti or Rock Mountain Elk | 0 |
| **Fish** | 3 |
| **Macroinvertebrates** | 4 |

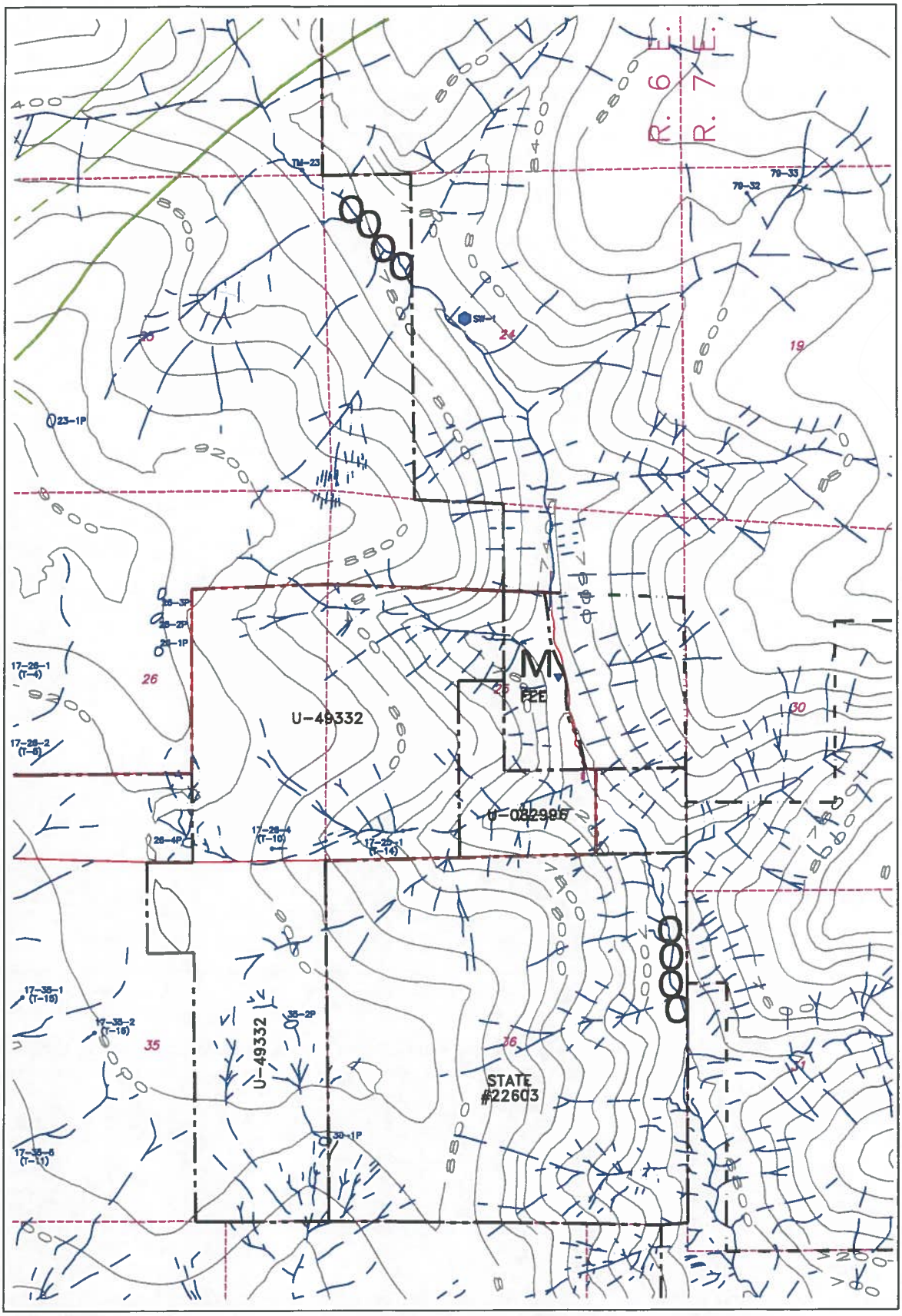
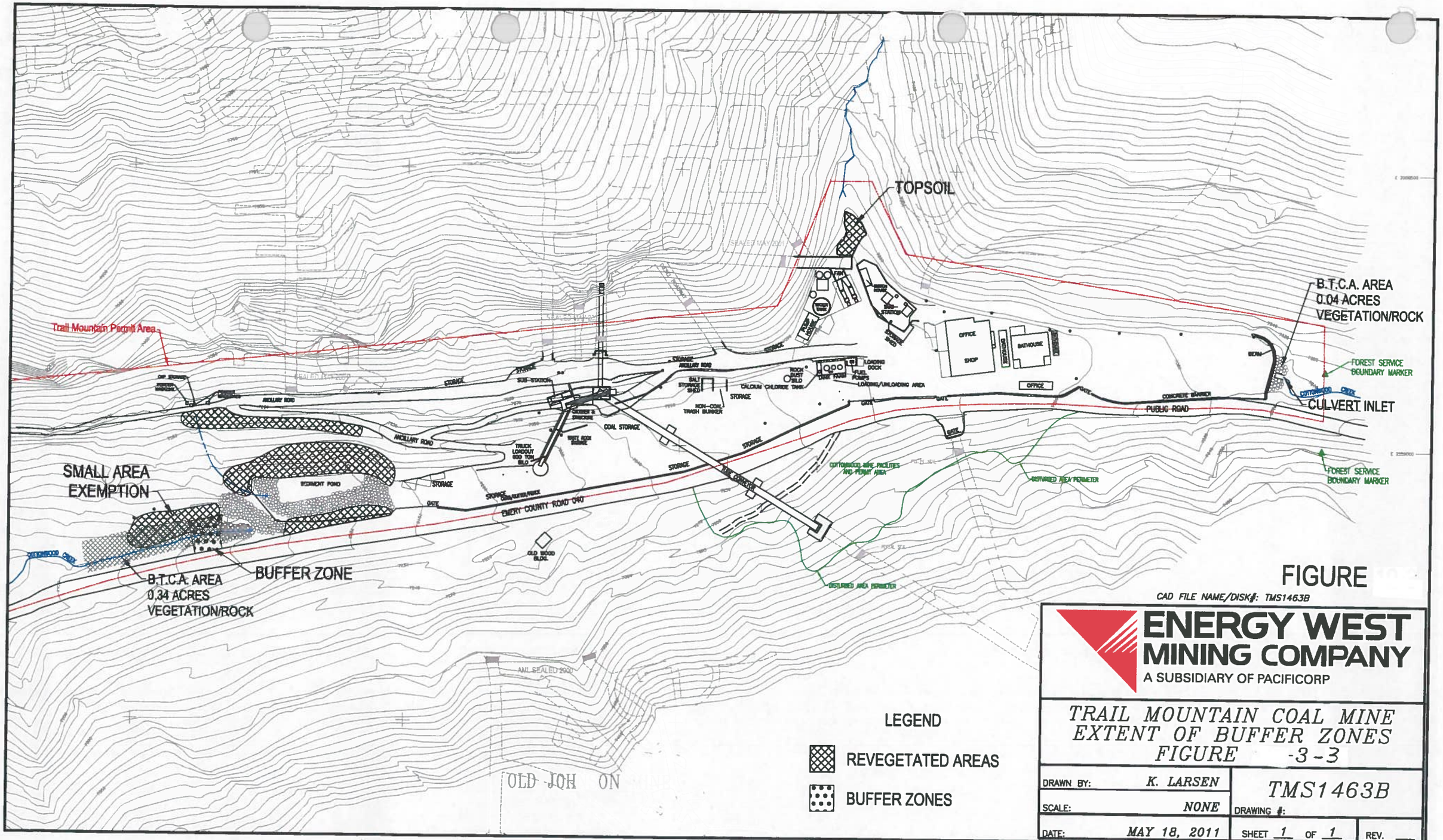



Figure 3-1 : Macroinvertebrate Sampline Stations in Relation to Trail Mountain Mine Portal Mountain Mine Portal and Loading Facilities (T17S, R6E).

M = Portal Area

O = Sampling Area




FIGURE

CAD FILE NAME/DISK#: TMS1463B

**ENERGY WEST MINING COMPANY**
A SUBSIDIARY OF PACIFICORP

*TRAIL MOUNTAIN COAL MINE*
*EXTENT OF BUFFER ZONES*
*FIGURE -3-3*

| | | | |
|---|---|---|---|
| DRAWN BY: | K. LARSEN | TMS1463B | |
| SCALE: | NONE | DRAWING #: | |
| DATE: | MAY 18, 2011 | SHEET 1 OF 1 | REV. |

APPENDIX 3-9-1

SEED MINES RECLAMATION AND RVEGETATION OF THE MINE

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 9-1

# SEED MIXES

# for

# RECLAMATION AND REVEGETATION

# OF THE

# TRAIL MOUNTAIN NO. 9 MINE

2/15/90

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

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| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

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| ATTACHMENT B | APPROVAL OF REFERENCE AREAS |
| ATTACHMENT C | PLAN FOR SAMPLING THE REGRADED SURFACE TO CONFIRM SALINITY VALUES |

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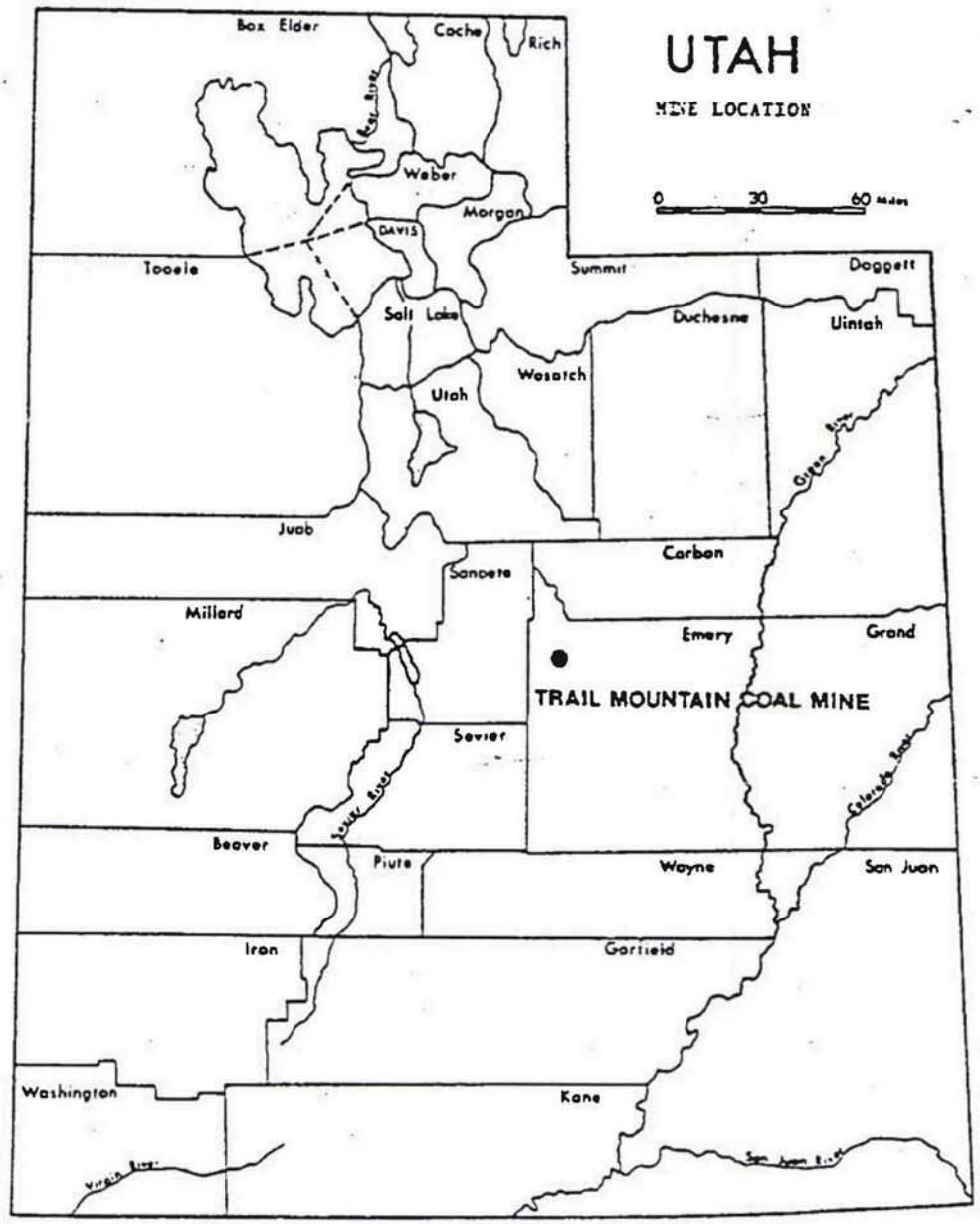
and
Ronald J. Kass, M.S.

December 1983


UTAH
MINE LOCATION
0 30 60 Miles
Box Elder
Cache
Rich
Weber
Morgan
DAVIS
Tooele
Summit
Daggett
Salt Lake
Duchesne
Uintah
Wasatch
Utah
Juab
Carbon
Sanpete
Millard
Emery
Grand
TRAIL MOUNTAIN COAL MINE
Sevier
Beaver
Piute
Wayne
San Juan
Iron
Garfield
Washington
Kane

# INTRODUCTION

The Trail Mountain Coal Mine is located in Cottonwood Canyon approximately 12 miles northwest of Orangeville, Utah. The mine area is a predisturbed site, having been in operation since 1948. As such, no premining conservation or reclamation measures were taken i.e. topsoil stockpiling from disturbed areas. The mine area is situated between the slopes (35° to 48°) of Cottonwood Canyon. For a map that illustrates the study area, boundaries and adjacent areas of Trail Mountain Mine, refer to Map B. Generally, the west slope has been disturbed by the mining activity. To create access roads to surface facilities, soils were pushed from this slope down to the canyon floor where Cottonwood Creek dissects the properties (see Map C). An 1,800 ft culvert was placed 12 feet below these translocated soils enabling the stream to continue its course.

The total surface disturbance of the Trail Mountain Coal Mine area is 9.61 acres. Much of this area has been subjected to years of soil compaction by heavy equipment and automobiles. Surface facilities and structures include a bathhouse, office/shop, substation, portals, storage areas, coal handling/loadout system, fan, and fuel storage area. Surface disturbances include: Cottonwood Creek, Parking areas, a drainage*, access roads, and a sediment pond.

* This preexisting, heavily wooded drainage occurs on the north slope just above the west portal and adjacent to the mine office/shop building. It will be referred to as such in the following text.

The mine site is not a major migration route for big game and other wildlife. Vegetation, soils, geology, hydrology and wildlife are typical of the general area. For specific information on each of these topics, refer to their respective chapters in the Mining and Reclamation Plan of the Trail Mountain Coal Mine.

Plant Communities

Previous vegetative studies indicated four major plant communities within the immediate mine area. The community types were 1) Conifer, 2) Pinyon-Juniper, 3) Riparian and 4) Grassland-Shrub. For a vegetation map of the mine area, refer to Map A. Two of these communities, the Grassland-Shrub and Riparian, have been disturbed from the mining activities. For quantitative and qualitative data of each of the four communities refer to Chapter 9 of the Mining and Reclamation Plan (MRP).

Vegetation Reference Areas

Reference areas were chosen as success standards for the revegetation of Grassland-Shrub and Riparian Plant Communities of the Trail Mountain Coal Mine area. These communities are within the permit boundaries and closely simulate the predisturbance plant communities. Each reference area is at least one acre and was chosen for similarities with respect to slope aspect, soils, elevation and management. These areas were surveyed and permanently

marked. For exact locations refer to Map A.

The range condition of the reference areas were listed as fair by the Soil Conservation Service (SCS). The SCS also estimated productivity for the Riparian Community to be 2,500 lbs/acre and the Grassland-Shrub Community to be 900 - 1000 lbs/acre (see Attachment A). These areas will be properly managed throughout mining and reclamation activities. No future disturbances by mining activities or changes in livestock management will be permitted on these areas. Due to inaccessibility of these areas, fencing will not be needed to prevent future land disturbances. Reference area site locations have been approved by the Utah Division of Oil Gas and Mining (see approval letter, Attachment B).

TABLE A9-1: Plant species suggested for revegetation of the Grassland-Shrub community and Mixture I (Vegetational Test Plots) at the Trail Mountain Coal Mine, Utah.

| BOTANICAL NAME | COMMON NAME | *LBS/ACRE |
|---|---|---|
| **GRASS** | | |
| *Agropyron trachycaulum* | Slender wheatgrass ✓ | 2.70 |
| *Bromus carinatus* | Mountain brome ✓ | 1.21 (1.21) |
| *Elymus cinerus* | Great Basin wildrye ✓ | 3.30 |
| *Oryzopsis hymenoides* | Indian ricegrass | 2.30 |
| **FORBS** | | |
| *Achillea millefolium var. lanulosa* | Western yarrow ✓ | .08 |
| *Astragalus cicer* | Sicklepod milkvetch ✓ | .50 |
| *Lomatium nuttallii* | Nuttall lomatium | 1.60 |
| *Melilotus officinalis* | Yellow sweetclover ✓ | .30 |
| *Penstemon palmerii* | Palmer penstemon | .10 |
| **SHRUBS** | | |
| *Amelanchier utahensis* | Utah serviceberry | 3.30 |
| *Purshia tridentata* | Antelope bitterbrush | 5.60 |
| *Symphoricarpos oreophilus* | Mountain snowberry | T |
| | TOTAL PURE LIVE SEED | 20.9 |

**SUBSTITUTIONAL SPECIES**

| | |
|---|---|
| *Poa pratensis* | Kentucky bluegrass |
| *Artemisia ludoviciana* | Louisiana sage |
| *Lupinus argenteus* | Silvery lupine |
| *Artemisia frigida* | Fringed sage |
| *Cercocarpus montanus* T | True Mt. mahogany |
| *Atriplex canescens* T | Fourwing saltbush |
| *Rhus trilobata* T | Skunkbush |
| *Agropyron dasystachyum* | Thickspike wheatgrass |
| *Agropyron smithii* | Bluestem wheatgrass |
| *Atriplex confertifolia* T | Shadescale |
| *Chrysothamnus viscidiflorus* | Low rabbitbrush |

*Seeding rates based on broadcasting 52 PLS/ft$^2$.
T=Transplant-containerized stock

TABLE A9-2 Seed costs for the Grassland-Shrub Community

| BOTANICAL NAMES | COST/LB(PLS) | LBS/ACRE | COST/ACRE | TOTAL COST/RECLAIMED AR |
|---|---|---|---|---|
| GRASSES | | | | |
| *Agropyron trachycaulum* | 2.55 | 2.7 | 6.88 | 43.34 |
| *Bromus carinatus* | 3.50 | 1.2 | 4.20 | 26.46 |
| *Elymus cinereus* | 9.20 | 3.3 | 30.36 | 191.26 |
| *Oryzopsis hymenoides* | 9.00 | 2.3 | 20.70 | 130.41 |
| FORBS | | | | |
| *Achillea millefolium* | 27.00 | .08 | 2.16 | 13.00 |
| *Astragalus cicer* | 4.20 | .50 | 2.10 | 13.23 |
| *Mililotus officinalis* | .68 | .30 | .20 | 1.26 |
| *Penstemon palmerii* | 35.00 | .10 | 3.50 | 22.05 |
| *Lomatium nuttallii* | 20.00 | 1.6 | 32.00 | 201.00 |
| SHRUBS | | | | |
| *Amelanchier utahensis* | 62.85 | 3.3 | 207.40 | 1,306.62 |
| *Purshia tridentata* | 14.00 | 5.6 | 78.40 | 493.92 |
| | | | | |
| SUBSTITUTIONAL SPECIES | | | TOTAL | $2,442.55 |
| *Agropyron dasystachyum* | 3,90 | | | |
| *Agropyron smithii* | 2.40 | | | |
| *Poa pratensis* | 1.40 | | | |
| *Artemisia ludoviciana* | 60.00 | | | |
| *Lupinus argenteus* | 70.00 | | | |
| *Artemisia frigida* | 90.00 | | | |
| *Chrysothamnus vicidiflorus* | 200.00 | | | |

TABLE A9-3: Plant species suggested for revegetation of the Riparian Community of the Trail Mountain Coal Mine, Utah.

| BOTANICAL NAME | COMMON NAME | *LBS/ACRE |
|---|---|---|
| **GRASS** | | |
| *Bromus carinatus* | Mountain brome | 3.20 |
| *Elymus cinereus* | Great Basin wildrye | 8.00 |
| *Poa pratensis* | Kentucky bluegrass | .50 |
| **FORBS** | | |
| *Aster chilensis* | Pacific aster | .50 |
| *Clematis liqusticifolia* | Western virginbower | .60 |
| *Melilotus officinalis* | White sweetclover | 1.00 |
| *Penstemon eatonii* | Eaton penstemon | .20 |
| **SHRUBS** | | |
| *Ribes aureum* | Golden currant | 1.00 |
| *Rosa woodsii* | Wood rose | T |
| *Sambucus caerulea* | Blue elderberry | 1.60 |
| *Salix exiqua* | Sandbar willow | T |
| | TOTAL PURE LIVE SEED | 16.10 |
| **SUBSTITUTIONAL SPECIES** | | |
| *Phalaris arundinacea* | Reed canarygrass | |
| *Aster glaucodes* | Blue aster | |
| *Prunus viginiana var melanocarpa* | Chokecherry | |
| *Populus angustifolia* T | Narrowleaf cottonwood | |

*Seeding rates based on broadcasting 52 PLS/ft$^2$.
T=Transplant-containerized stock

TABLE A9-4: Seed cost for the Riparian community.

| BOTANICAL NAMES | LBS COST/(PLS) | LBS/ACRE | COST/ACRE | COST/ RECLA AREA |
|---|---|---|---|---|
| **GRASSES** | | | | |
| *Poa pratensis* | 1.40 | .5 | .70 | 1.75 |
| *Elymus cinereus* | 9.20 | 8.0 | 73.60 | 184.00 |
| *Bromus carinatus* | 3.50 | 3.2 | 11.20 | 28.00 |
| **FORBS** | | | | |
| *Aster chilensis* | 94.00 | .5 | 47.00 | 117.50 |
| *Clematis ligusticifolia* | 20.00 | .6 | 12.00 | 30.00 |
| *Melilotus alba* | .68 | .6 | .40 | 1.00 |
| *Penstemon eatonii* | 38.00 | .10 | 3.80 | 9.50 |
| **SHRUBS** | | | | |
| *Ribes aureum* | 90.00 | 1.00 | 40.00 | 100.00 |
| *Sambueus caerulea* | 30.00 | 1.6 | 48.00 | 120.00 |
| | | TOTAL | | $591.75 |
| **SUBSTITIONAL SPECIES** | | | | |
| *Phalaris arundinacea* | 3.00 | | | |
| *Aster glaucodes* | 94.00 | | | |
| *Prunus virginiana var. melanocarpa* | 15.00 | | | |

TABLE A9-5 Implementation and material cost of containerized stock.

| BOTANICAL NAME | COMMON NAME |
|---|---|
| *Artemisia abrotanum* | Oldman wormwood |
| *Atriplex canescens* | Fourwing saltbush |
| *Atriplex confertifolia* | Shadscale |
| *Cercocarpus montanus* | True Mt. mahogany |
| *Populus angustifolia* | Narrowleaf cottonwood |
| *Rhus trilobata* | Skunkbush |
| *Salix exigua* | Sandbar willow |
| *Symphoricarpus oreophilus* | Mountain snowberry |

GRASSLAND-SHRUB COMMUNITY

Plant Materials
90 individuals/acre @ .79/plant = $71.10 x 6.3 acres= $447.93

Labor
90 individuals/acre x 6.3 acres = 567
567/20 individuals planted/hr. =28.3 hrs.
28.3 hrs. @ $15.00 = $425.25

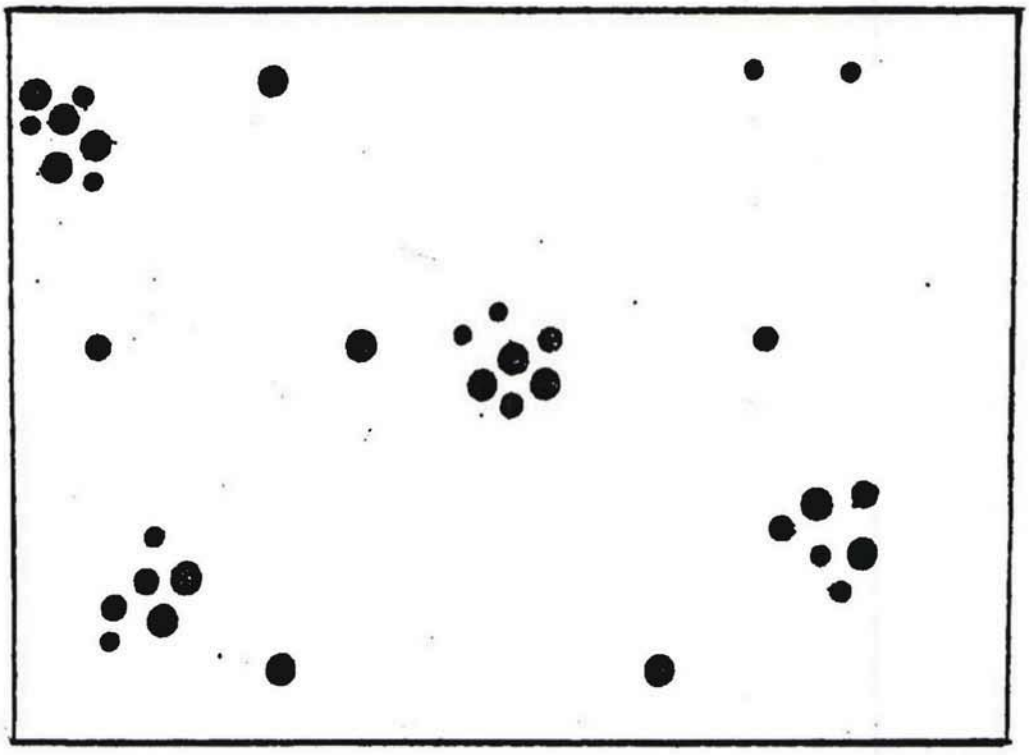
RIPARIAN COMMUNITY

Plant Materials
90 individuals/acre @ .79/plant = $71.10 x 2.5 acres = $177.75

Labor
90 individuals/acre x 2.5 acres = 225
225/20 individuals planted/hr. = 11.2 hrs.
11.2 hrs. @ $15.00/hr. = $168.75

Note: Willows may be fresh-cut shoots from Cottonwood Creek area. To be planted on 3' centers each side of reclaimed channels.

# IMPLEMENTATION OF CONTAINERIZED STOCK OF THE GRASSLAND-SHRUB COMMUNITY*



● Symphoricarpos oreophilus

● Cercocarpus montanus

● Artemisia abrotanum

SCALE 1" = 25'

* Shrub density will be maintained at 2% of the present native plant density.

TABLE A9-6: Plant species suggested for Mixture II on Vegetational Test Plot at Trail Mountain Coal Mine, Utah.

| BOTANICAL NAME | COMMON NAME | LBS/ACRE |
|---|---|---|
| **GRASS** | | |
| *Agropyron spicatum var. inerme* | Beardless bluebunch wheatgrass | 3.00 |
| *Agropyron tricophorum* | Pubescent wheatgrass | 4.80 |
| *Bromus inermis* | Smooth brome | 2.50 |
| *Dactylis glomerata* | Orchardgrass | .80 |
| **FORBS** | | |
| *Hedysarum boreale var. utahensis* | Utah sweetclover | 2.00 |
| *Linum lewsii* | Blue Flax | .25 |
| *Penstemon eatonii* | Eaton penstemon | .10 |
| *Sanquisorba minor* | Small burnet | 1.20 |
| *Sphaeralcea grossulariaefolia* | Gooseberry globemallow | .13 |
| **SHRUBS** | | |
| *Artemisia abrotanum* | Oldman wormwood | T |
| *Artemisia tridentata ssp. tridentata* | Big sagebrush | .10 |
| *Chrysothamnus nauseosus ssp. nauseousus* | Rubber rabbitbrush | .10 |
| | TOTAL PURE LIVE SEED | 14.98 |

*Seeding rates based on broadcasting 52 PLS/ft$^2$.
T=Transplant-containerized stock

TABLE A9-7: Seed cost for Test Plot (Mixture II).

| BOTANICAL NAMES | LBS COST/(PLS) | LBS/ACRE | COST/ACRE | RECL COST/ ARE |
|---|---|---|---|---|
| **GRASSES** | | | | |
| *Agropyron spicatum* | 7.50 | 3.0 | 22.50 | 6.75 |
| *Agropyron tricophorum* | 1.54 | 4.8 | 7.39 | 2.21 |
| *Bromus inermis* | 1.23 | 2.5 | 3.07 | .92 |
| *Dactylis glomerata* | .88 | .8 | .70 | .21 |
| **FORBS** | | | | |
| *Hedysarum boreale* | 45.40 | 2.0 | 90.80 | 27.24 |
| *Linum lewisii* | 15.00 | .25 | 3.75 | 1.12 |
| *Penstemon eatonii* | 38.00 | .10 | 3.80 | 1.14 |
| *Sanquisorba minor* | 1.50 | 1.2 | 1.80 | .54 |
| *Sphaeraleca grossulariefolia* | 45.50 | .13 | 5.90 | 1.77 |
| **SHRUBS** | | | | |
| *Artemisia tridentata ssp. tridentata* | 35.00 | .10 | 3.50 | 1.05 |
| *Chrysothamnus nauseosus ssp. nauseosus* | 68.00 | .10 | 6.80 | 2.04 |
| | | | TOTAL | $44.99 |

TABLE A9-8: Plant species suggested for revegetation of the Trail Mountain Coal Mine area. This table shows species adaptation qualities.

| BOTANICAL NAMES | COMMON NAMES | RANGE OF ADAPTATION** |
|---|---|---|
| **GRASSES** | | |
| *Agropyron dasystachyun* | Thickspike wheatgrass | H,S,Q, |
| *Agropyron smithii* | Bluesteam wheatgrass | H |
| *Agropyron spicatum var. inerme* | Beardless bluebunch wheatgrass | Q |
| *Agropyron trachycaulum* | Slender wheatgrass | Q,S,M |
| *Agropyron tricophorum* | Pubescent wheatgrass | I,Q,S |
| *Bromus carinatus* | Mountain brome | Q,S,L |
| *Bromus inermis* | Smooth brome | I,Q,S,M |
| *Dactylis glomerata* | Orchardgrass | I,Q |
| *Elymus cinereus* | Great Basin wildrye | Q,S,M |
| *Oryzopsis hymenoides* | Indian ricegrass | W,M |
| *Poa pratensis* | Kentucky bluegrass | S |
| **FORBS** | | |
| *Achillea millefolium var. lanulosa* | Western yarrow | A,M |
| *Aster chilensis* | Pacific aster | Q,M |
| *Astragalus cicer* | Sicklepod milkvetch | A,N,Q,S,M |
| *Clematis ligusticifolia* | Western virginsbower | A |
| *Hedysarum boreale var. utahensis* | Utah sweetvetch | A,N,Q,W |
| *Linum lewisii* | Blue flax | A,Q,W,M |
| *Lomatium nuttallii* | Nuttall lomatium | Q |
| *Melilitus alba* | White sweetclover | Q,N,H |
| *Melilotus officinalis* | Yellow sweetclover | Q,N,H |
| *Penstemon eatonii* | Eaton penstemon | A,Q,S |
| *Penstemon palmerii* | Palmer penstemon | A,Q,S |
| *Sanquisorba minor* | Small burnet | I,W |
| *Sphaeralcea grossulariaefolia* | Gooseberry globemallow | A,M |
| **SHRUBS** | | |
| *Amelanchier utahensis* | Utah serviceberry | A,W |
| *Artemisia abrotanum* | Oldman wormwood | A,C,I,Q |
| *Artemisia tridentata ssp. tridentata* | Big sagebrush | W |
| *Atriplex confertifolia* | Shadescale | H,C |
| *Chrysothamnus nauseosus ssp. naueosus* | Rubber rabbitbrush | Q,H |
| *Chrysothamnus viscidiflorus* | Low Rabbitbrush | H |
| *Purshia tridentata* | Antelope bitterbrush | Q,W |
| *Ribes aureum* | Golden current | A,Q |
| *Rosa woodsii* | Wood rose | A,C,W |
| *Salix exiqua* | Sandbar willow | C |
| *Sambucus caerulea* | Blue elderberry | A,W |

TABLE A9-8: Continued

## FOOTNOTES

* Range of species adaptation prepared from published literature and field experience of *MT. NEBO SCIENTIFIC.*

**A- aesthetically pleasing

C- containerized stock

I- introduced

N- nitrogen fixing

Q- quick establishment

S- sod-forming

W- palatable to wildlife

L- low salt tolerance

M- moderate salt tolerance

H- high salt tolerance

ATTACHMENT A

United States Department of Agriculture
Soil Conservation Service
350 North 4th East
Price, Utah 84501

November 3, 1983

Allen Childs
Natomas Trail Mountain Coal Company
P. O. Box 370
Orangeville, Utah 84537

Dear Allen:

The riparian area along the streambank where the willows and narrowleaf cottonwood grows is about 2,500 lbs. per acre production. The site is in fair condition.

The Salina wildrye site on the steep side hill is producing about 900-1,000 lbs. per acre. The condition of this site is good.

George S Cook

George S. Cook
Range Conservationist
Price, Utah

ATTACHMENT B

STATE OF UTAH
NATURAL RESOURCES
Oil, Gas & Mining

Scott M. Matheson, Governor
Temple A. Reynolds, Executive Director
Dr. G. A. (Jim) Shirazi, Division Director

241 State Office Building • Salt Lake City, UT 84114 • 801-533-5771

December 12, 1983

Mr. Allen P. Childs, Engineer
Trail Mountain Coal Company
P. O. Box 551
Orangeville, Utah 84537

RE: Reference Areas Approval
Trail Mountain Mine
ACT/015/009, Folder No. 2 & 4
Emery County, Utah

Dear Allen:

The Division has received and reviewed the information submitted on December 1, 1983 by Trail Mountain Coal, concerning the request for final approval of the Riparian Community and Sagebrush - Grass Community reference areas.

The areas have been permanently marked and mapped and a productivity statement for each provided as previously requested by the Division during the mine site visit of November 7, 1983. The reference areas as delineated are hereby approved.

Sincerely,

Steven Cox

STEVE COX
RECLAMATION BIOLOGIST

SC/jvb

cc: Allen Klein, OSM
Lou Hamm, OSM
Pam Grubaugh-Littig, DOGM
Mary Boucek, DOGM

2/15/90

A9-1-14

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[The following replaces the section from APPENDIX 9-1, that was entitled "ATTACHMENT C; CONDITION 1; OFFICE OF SURFACE MINING STIPULATIONS; PLAN FOR SAMPLING THE REGRADED SURFACE OF THE TRAIL MOUNTAIN MINE SITE TO CONFORM SALINITY VALUES ARE NOT EXCEEDED".]

## ATTACHMENT C

## PLAN FOR SAMPLING THE REGRADED SURFACE OF THE TRAIL MOUNTAIN MINE SITE TO CONFIRM SALINITY VALUES ARE NOT EXCEEDED

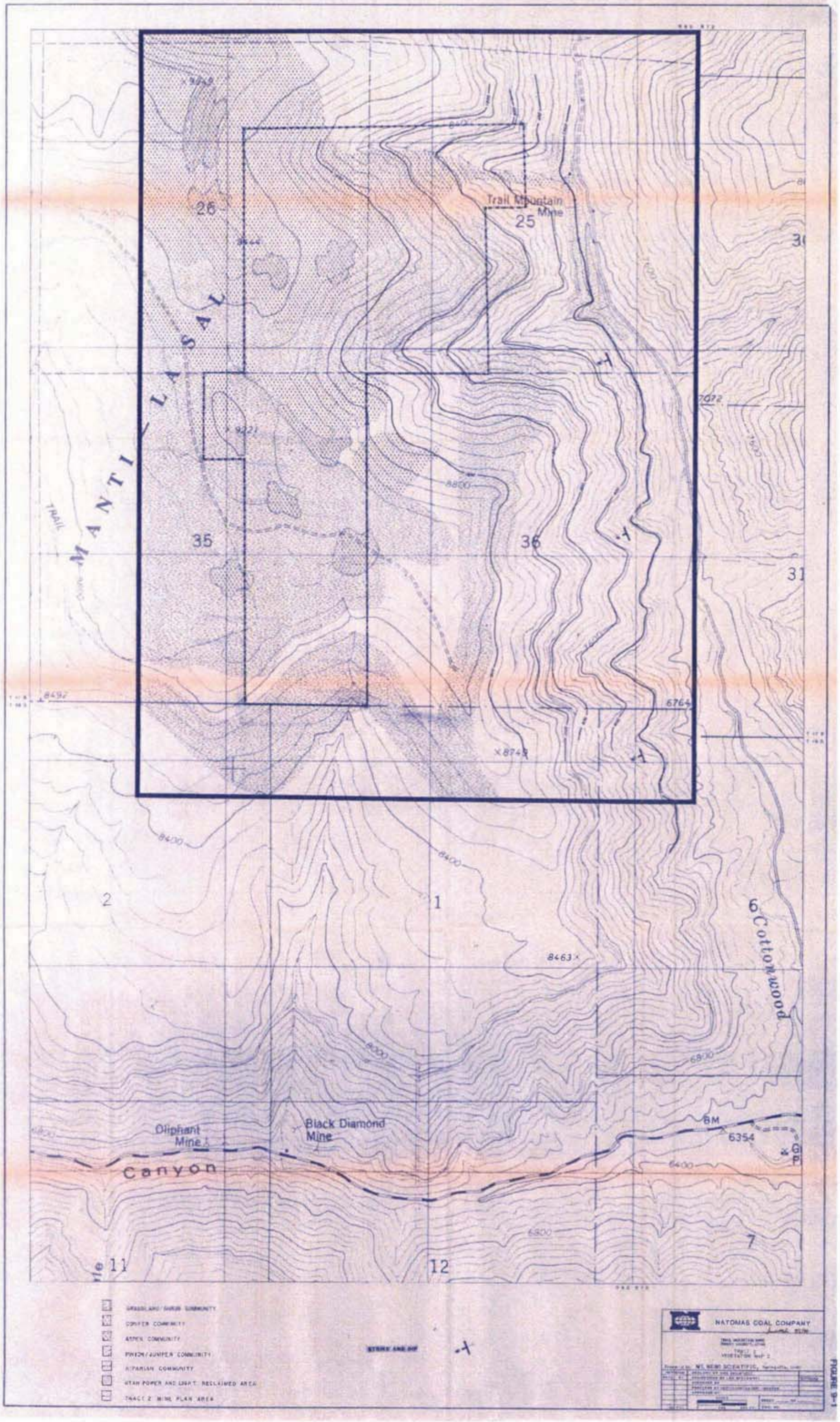
The following is a revised version of the above with recommendations incorporated from Dan Duce (Soils Specialist, DOGM) from a memo dated February 24, 1988 to John Whitehead (Permit Supervisor, DOGM). These recommendations were also referred to in a letter from John Whitehead to Dan Guy (Beaver Creek Coal Company) date May 27, 1988.

### POST-GRADING SOIL SAMPLING

Soil sampling will be conducted at the time of final reclamation after earthmoving and recontouring procedures and prior to the seedbed preparation techniques (see Appendix 9 for more on reclamation and revegetation techniques). One goal of the earth moving procedures is to place the substitute soil so that the top 12 inches of the growing media has EC values of 8 mmhos/cm (or less) and the underlying 36 inches of soils have values less that 16 mmhos/cm. Soil sampling will provide a method to determine if these objectives are met.

### SAMPLING DESIGN

Soil sample locations will be determined by a grid sampling design, placed at regular intervals on the grid. Distance between sample locations will be no more than 100 feet over the entire disturbed area. At each sample grid location three (3) composite soil samples will be collected: one sample from the top 12 inches and two samples from the underlying 36 inches. Each sample will then be analyzed at a soils laboratory for their EC values. If the EC values exceed the above limits, additional sampling may be necessary to locate the exact area of the problem soils so that mitigation may be implemented. A Subset of 20-30 of these samples will be randomly picked and also be analyzed for fertility to be used for fertilization using Division recommendation.



Trail Mountain Mine
26
25
35
36
MANTI LA SAL
TRAIL
8800
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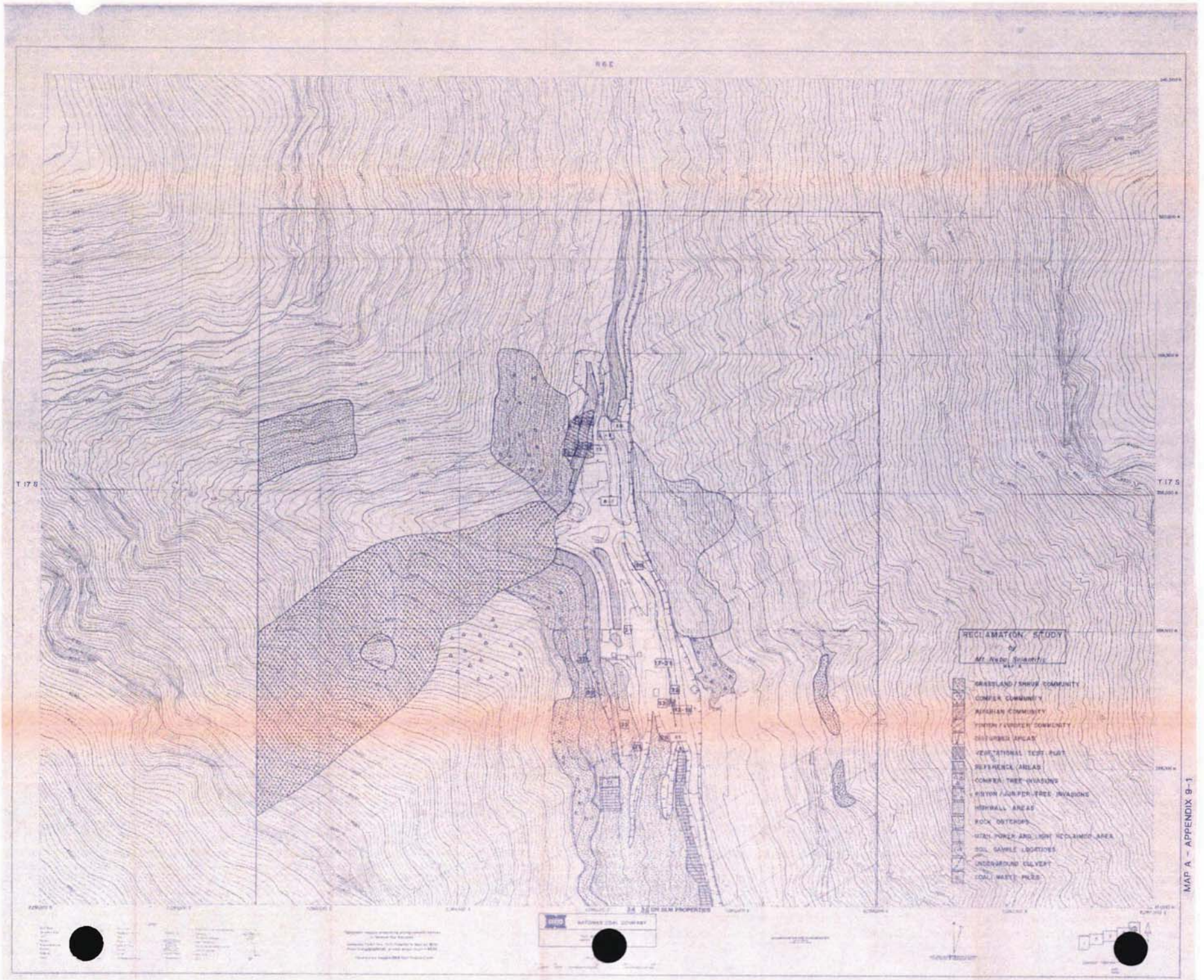
7072
2
1
6
Cottonwood
Oliphant Mine
Black Diamond Mine
Canyon
BM 6354
6400
6800
8000
7
11
12
CONIFER COMMUNITY
ASPEN COMMUNITY
RIPARIAN COMMUNITY
UTAH POWER AND LIGHT RECLAIMED AREA
NATOMAS COAL COMPANY
FIGURE 9-1


R6E
T 17 S
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RECLAMATION STUDY
BY
GRASSLAND / SHRUB COMMUNITY
CONIFER COMMUNITY
RIPARIAN COMMUNITY
PINYON / JUNIPER COMMUNITY
DISTURBED AREAS
VEGETATIONAL TEST PLOT
REFERENCE AREAS
CONIFER TREE INVASIONS
PINYON / JUNIPER TREE INVASIONS
HIGHWALL AREAS
ROCK OUTCROPS
WELL POWER AND LIGHT RECLAIMED AREA
SOIL SAMPLE LOCATIONS
UNDERGROUND CULVERT
COAL WASTE PILES
MAP A - APPENDIX 9-1

# APPENDIX 9-2

# SOIL AND VEGETATION TEST PLOT MONITORING AT THE TRAIL MOUNTAIN COAL MINE:

## 1988 UPDATE

10/19/89

1988

VEGETATION DATA

# REVEGETATION TEST PLOT MONITORING OF THE TRAIL MOUNTAIN COAL MINE: 1988

by

Patrick D. Collins, Ph.D.

## INTRODUCTION

The following is a summary of the 1988 sampling results of the Revegetation Test Plots on the properties of the Trail Mountain Coal Mine in Emery County, Utah. The research test plots were implemented in the fall of 1984. Vegetation sampling has been implemented on the plots since the growing season of 1985. The plots are beginning to show interesting patterns that should be outlined subsequent to sampling in 1989.

## METHODS

Quantitative and qualitative data were taken on each of the test plots. Sampling methods were implemented this year exactly the same way they were in the previous years. These methods have been described adequately in earlier reports. The five tables of this report were numbered 16 through 20 so that they could be a simple addition to the report of November 1987 entitled "Results and Summary of Vegetation Test Plot Monitoring at the Trail Mountain Coal Mine".

## RESULTS AND DISCUSSION

Summaries for the sampling data from 1988 are shown on Tables 16 - 20. Some patterns are beginning to appear and will be discussed

should be noted in this report that may be used in a final report of the test plots. First, much of Utah has had a dry year. The soils and vegetation on the plots this year appeared drier than previous years, possibly contributing to the slight decline in total living cover. However, the plots were also sampled later in the growing season this year, which may also have contributed to the results. Seasonal fluctuations in precipitation should be correlated with some of the cover and composition fluctuations of the test plots. Additionally, we have not fertilized the plots since it was implemented in 1984. A follow up treatment of nitrogen and phosphorus may be beneficial to these plots and to the reclaimed surface at the time of final reclamation.

It should also be noted that the disturbance at one end of the test plot caused by drilling has been reclaimed and recontoured to the slope of the original test plot. This area could be reseeded with slight adjustments to the seed mix and monitored separately for additional information that would be helpful at the time of final reclamation.

I am encouraged, however, on the progress of the test plots. Germination and growth was good according to the data of 1985. We had a problem with cattle on the plot in 1986 (prior to fencing the plot) that depleted that year's production. We were concerned at that time that this may destroy our experiments, but results from our 1987 sampling showed the seeded plants species to have a remarkable tolerance to grazing. The results (to date) show encouraging revegetation potential with the present "spoil" material at the mine site.

# APPENDIX 3-9-2

# SOIL AND VEGETATION TEST PLOT MONITORING

APPENDIX 9-2

# SOIL AND VEGETATION TEST PLOT MONITORING AT THE TRAIL MOUNTAIN COAL MINE:

1987 UPDATE

2/1/88

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# SOILS AND VEGETATION TEST PLOT MONITORING AT THE TRAIL MOUNTAIN COAL MINE:

## AN UPDATE

by
Patrick D. Collins, Ph.D.

*MT. NEBO SCIENTIFIC RESEARCH & CONSULTING*

P.O. Box 337
Springville, Utah
84663

November 1987

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# RESULTS AND SUMMARY OF VEGETATION TEST PLOT MONITORING AT THE TRAIL MOUNTAIN COAL MINE

by

Patrick D. Collins
November 1987

## INTRODUCTION

Vegetation test plot were implemented between October 20 and November 7, 1984. Test plots were designed to test establishment of plant cover on the existing soils (spoils) on the Trail Mountain mine site. Vegetation test plot methods and design were described in the Mining & Reclamation Plan (MRP), Appendix 9 (pages 18 through 38). Information on soils and spoils of the mine site and those that were used for the reclamation test plots can also be located in the MRP, Chapter VIII (pages 8-1 through 8-15) and Appendix 9 (pages 15 through 17 and pages 39 through 44). Within these pages are explanations and justifications for the design of the test plots. A brief history and summary of previous soil sampling including results of more recent soil testing will also be submitted and accompany this report.

## METHODS

Vegetation monitoring was accomplished on a yearly basis beginning in the growing season of 1985. Sampling has been accomplished in the same month (July) each year in an attempt to decrease between-year variation as much as possible for future statistical comparisons. To date, sampling has been accomplished in July for three consecutive years (1985, 1986 & 1987). Data summaries of these years are included in this report.

Quantitative and qualitative data were taken on each of the two areas called Species Mixture I & Species Mixture II. Bi-directional random placement of sampling plots were designed to provide unbiased accuracy of the data compiled. A randomized block design was implemented to insure adequate representation of the entire plot by placing regularly located points along one side of the plot. From these points, random numbers were generated to penetrate the test plot and locate the sampling points. Cover estimates were made using ocular methods with meter square quadrats. Species cover, total cover, composition and relative frequency were also assessed from the quadrats. Also recorded on data sheets were estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes.

Density of woody plant species were not recorded because, although shrubs were planted, each year their establishment and cover has been relatively insignificant. However, frequency values of the woody plants are included.

Sampling adequacy for cover was achieved each year using formulas from Snedocor and Cochran (1980), insuring that 90% of the samples were within 10% of the true mean of the test plots. All sample means, standard deviations, and sample sizes were included in this report to enable the reviewers to apply further statistical tests if desired.

## RESULTS

All results from the 3 test plot sampling years are listed on Tables 1 - 15, however, some of the summarized results are noted below.

### Total Cover

Total living cover for the Species Mixture I plot for the three years sampled went from 32.60% (1985) down to 28.00% (1986) then up again to 69.75% (1987). Similarly, Species Mixture II plot followed the pattern: from 38.57%, to 30.50%, then to 60.90% in those years, respectively. The probable reason for the decrease in cover between 1985 and 1986 was that just prior to the date of sampling, the plot was severely disturbed by livestock (a fence to exclude livestock was not constructed at that time). The Emery County Cattlemen's Association moved a large number of cattle from the lower valleys, past the mine area, to higher elevations. The cattle were often left unattended to graze at their own pace until they reached the higher range. Cattle were moving past the mine in 1986 from June 21 through June 29. Even more extensive damage was done on the weekend between those dates because few workers were nearby to divert the cattle from the mine area. Consequently, almost the entire year's biomass production (to date) was lost.

The plots were given nearly a month to recover prior to sampling. It appeared at that time that, although the plots were severely damaged, if adequate natural precipitation occurred, chances for plot recovery were good. Photographs of the plot before and after the damage are available.

A fence was then constructed to exclude the cattle in the following years. As can be noted, a sharp increase of cover occurred in 1987. Adequate moisture patterns and the exclusion of the cattle the following year probably allowed most the plant species to recover fully.

One can use the tables to note changes and patterns in plant species cover and relative frequencies. Composition changes in lifeform can also be noted from year to year. Most changes have been expected, and will continue to change as plant species compete and finally become a stable community.

TABLE 1: 1985 monitoring results for the vegetation test plots of the Trail Mountain Coal Mine, Utah. The table shows a plant species list and the plot it was found in. (Plot was sampled July 11, 1985).

| SCIENTIFIC NAME | COMMON NAME | SPECIES MIX | |
|---|---|---|---|
| Amalanchier utahensis | Utah serviceberry | I | - |
| Chrysothamnus nauseosus | Rubber rabbitbrush | | II |
| Purshia tridentata | Bitterbrush | I | |
| Achillea millefolium | Yarrow | I | |
| Atriplex powellii | Powell's saltbrush | I | II |
| Descurainia pinnata | Tansy mustard | I | |
| Hedysarum boreale | Northern sweetvetch | | II |
| Lupinus argenteus | Silk lupine | I | |
| Malcomia africa | African mustard | I | |
| Melilotus officinalis | Yellow sweet clover | I | |
| Salsola kali | Russian thistle | I | |
| Sanguisorba minor | Small burnet | | II |
| Agropyron cristatum | Western wheatgrass | I | |
| Agropyron spicatum | Bluebunch wheatgrass | | II |
| Agropyron intermedium var. trichophorum | Pubescent wheatgrass | | II |
| Bromus carinatus | Mountain brome | I | |
| Bromus commutatus | Hairy brome | | II |
| Bromus tectorum | Cheatgrass | I | II |
| Hordeum jubatum | Foxtail barley | I | |

(Data Sheet 1 of 5)

TABLE 2: 1985 SAMPLING RESULTS - MIXTURE I
Total cover and composition of the revegetation test plots of the Trail Mountain Coal Mine. The table shows means, standard deviations and sample sizes.

COVER - SPECIES MIXTURE I

| TOTAL COVER | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE * |
|---|---|---|---|
| Total Living Cover | 32.60 | 10.32 | 25 |
| Litter | -- | -- | 25 |
| Erosion Mat | 67.40 | 10.32 | 25 |
| Rock | -- | -- | 25 |

COMPOSITION - SPECIES MIXTURE I

| TOTAL COVER | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE * |
|---|---|---|---|
| Shrubs | 1.62 | 2.70 | 25 |
| Forbs | 7.81 | 5.87 | 25 |
| Grasses | 90.71 | 7.07 | 25 |

*Sample size insures 90% accuracy within 10% of the true mean.

(Data Sheet 2 of 5)

TABLE 3: 1985 SAMPLING RESULTS - SPECIES MIXTURE I
Mean percent cover, standard deviation, sample size and relative frequency by species of the revegetation test plots of the Trail Mountain Coal Mine.

SPECIES MIXTURE I

| SPECIES | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE | RELATIVE FREQUENCY |
|---|---|---|---|---|
| Amelanchier utahensis | .32 | .56 | 25 | 28.00 |
| Purshia tridentata | .16 | .36 | 25 | 16.00 |
| Achillea millefolium | .24 | .52 | 25 | 20.00 |
| Atriplex powellii | .20 | .50 | 25 | 16.00 |
| Descurainia pinnata | .16 | .63 | 25 | 8.00 |
| Lupinus argenteus | .68 | .63 | 25 | 60.00 |
| Malcomia africa | T | T | 25 | 4.00 |
| Melilotus officinalis | .88 | .73 | 25 | 72.00 |
| Agropyron cristatum | .08 | .28 | 25 | 8.00 |
| Bromus carinatus | 29.80 | 10.77 | 25 | 100.00 |
| Bromus tectorum | T | T | 25 | 4.00 |
| Hordeum jubatum | T | T | 25 | 4.00 |

(Data Sheet 3 of 5)

TABLE 4: 1985 SAMPLING RESULTS - MIXTURE II
Total cover and composition of the revegetation test plots of the Trail Mountain Coal Mine. The table shows means, standard deviations and sample sizes.

SPECIES MIXTURE II

| TOTAL COVER | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE |
|---|---|---|---|
| Total Living Cover | 38.57 | 10.62 | 25 |
| Litter | -- | -- | 25 |
| Erosion Mat | 61.19 | 10.36 | 25 |
| Rock | -- | -- | 25 |

COMPOSITION - SPECIES MIXTURE II

| | | | |
|---|---|---|---|
| Shrubs | .19 | .87 | 25 |
| Forbs | 5.10 | 5.03 | 25 |
| Grasses | 94.71 | 5.06 | 25 |

*Sample size insures 90% accuracy within 10% of the true mean.

(Data Sheet 4 of 5)

TABLE 5: 1985 SAMPLING RESULTS - SPECIES MIXTURE II
Mean percent cover, standard deviation, sample size and relative frequency by species of the revegetation test plots of the Trail Mountain Coal Mine.

SPECIES MIXTURE II

| SPECIES | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE | RELATIVE FREQUENCY |
|---|---|---|---|---|
| Chrysothamnus nauseosus | .05 | .22 | 21 | 4.00 |
| Atriplex powellii | .05 | .22 | 21 | 4.00 |
| Hedysarum boreale | 1.52 | 1.72 | 21 | 66.67 |
| Sanquisorba minor | .29 | .46 | 21 | 28.57 |
| Agropyron spicatum | .24 | .46 | 21 | 9.52 |
| Agropyron intermedium var. trichophorum | 31.67 | 9.96 | 21 | 100.00 |
| Bromus commutatus | .24 | 1.09 | 21 | 4.76 |
| Bromus tectorum | 5.00 | 3.46 | 21 | 95.24 |

(Data Sheet 5 of 5)

TABLE 6: 1986 monitoring results for the vegetation test plots of the Trail Mountain Coal Mine, Utah. The table shows a plant species list and the plot it was found in. (Plot was sampled July 28, 1986).

| SCIENTIFIC NAME | COMMON NAME | SPECIES MIX | |
|---|---|---|---|
| SHRUBS | | | |
| Amalanchier utahensis | Utah serviceberry | I | |
| Atriplex confertifolia | Shadscale | I | II |
| Purshia tridentata | Bitterbrush | I | |
| FORBS | | | |
| Achillea millefolium | Yarrow | I | |
| Astragalus cicer | Chickpea milkvetch | I | |
| Atriplex powellii | Powell's saltbrush | | II |
| Iva axillaris | Poverty sumpweed | I | II |
| Lupinus argenteus | Silk lupine | I | |
| Malcomia africa | African mustard | I | |
| Melilotus officinalis | Yellow sweet clover | I | II |
| Penstemon palmeri | Palmer penstemon | I | |
| Sanguisorba minor | Small burnet | | II |
| GRASSES | | | |
| Agropyron trachycaulum | Slender wheatgrass | I | |
| Agropyron intermedium var. trichophorum | Intermediate wheatgrass | | II |
| Bromus carinatus | Mountain brome | I | |
| Bromus inermis | Smooth brome | | II |
| Oryzopsis hymenoides | Indian ricegrass | I | |

(Data Sheet 1 of 5)

TABLE 7: 1986 SAMPLING RESULTS - SPECIES MIXTURE I

Total cover and composition of the revegetation test plots of the Trail Mountain Coal Mine. The table shows means, standard deviations and sample sizes.

COVER - SPECIES MIXTURE I

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE * |
|---|---|---|---|
| Total Living Cover | 28.00 | 5.32 | 25 |
| Litter | 9.56 | 7.61 | 25 |
| Erosion Mat | 41.80 | 18.53 | 25 |
| Rock | 8.84 | 7.16 | 25 |
| Bareground | 11.60 | 10.21 | 25 |

COMPOSITION - SPECIES MIXTURE I

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE * |
|---|---|---|---|
| Shrubs | 1.92 | 3.00 | 25 |
| Forbs | 22.76 | 20.88 | 25 |
| Grasses | 75.33 | 20.86 | 25 |

*Sample size insures 90% accuracy within 10% of the true mean.

(Data Sheet 2 of 5)

TABLE 8: 1986 SAMPLING RESULTS - SPECIES MIXTURE I

Mean percent cover, standard deviation, sample size and relative frequency by species of the revegetation test plots of the Trail Mountain Coal Mine.

SPECIES MIXTURE I

| SPECIES | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE | RELATIVE FREQUENCY |
|---|---|---|---|---|
| Amelanchier utahensis | .16 | .37 | 25 | 16.00 |
| Atriplex confertifolia | .12 | .44 | 25 | 8.00 |
| Purshia tridentata | .32 | .56 | 25 | 32.00 |
| Achillea millefolium | .52 | .51 | 25 | 36.00 |
| Astragalus cicer | .32 | .56 | 25 | 28.00 |
| Iva axillaris | .24 | 1.01 | 25 | 8.00 |
| Lupinus argenteus | .04 | .20 | 25 | 4.00 |
| Malcomia africa | .04 | .20 | 25 | 4.00 |
| Melilotus officinalis | 5.24 | 5.61 | 25 | 72.00 |
| Penstemon palmeri | .04 | .20 | 25 | 4.00 |
| Agropyron trachycaulum | 6.60 | 4.07 | 25 | 92.00 |
| Bromus carinatus | 13.92 | 6.82 | 25 | 100.00 |
| Oryzopsis hymenoides | .64 | 1.82 | 25 | 12.00 |

(Data Sheet 3 of 5)

TABLE 9: 1986 SAMPLING RESULTS - SPECIES MIXTURE II

Total cover and composition of the revegetation test plots of the Trail Mountain Coal Mine. The table shows means, standard deviations and sample sizes.

COVER SPECIES MIXTURE II

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE |
|---|---|---|---|
| Total Living Cover | 30.50 | 6.05 | 20 |
| Litter | 8.40 | 4.26 | 20 |
| Erosion Mat | 45.50 | 10.87 | 20 |
| Rock | 7.60 | 5.12 | 20 |
| Bareground | 7.00 | 4.32 | 20 |

COMPOSITION - SPECIES MIXTURE II

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE* |
|---|---|---|---|
| Shrubs | 0.74 | 2.62 | 20 |
| Forbs | 22.54 | 20.70 | 20 |
| Grasses | 76.72 | 20.80 | 20 |

*Sample size insures 90% accuracy within 10% of the true mean.

(Data Sheet 4 of 5)

TABLE 10: 1986 SAMPLING RESULTS - SPECIES MIXTURE II

Mean percent cover, standard deviation, sample size and relative frequency by species of the revegetation test plots of the Trail Mountain Coal Mine.

SPECIES MIXTURE II

| SPECIES | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE | RELATIVE FREQUENCY |
|---|---|---|---|---|
| Atriplex confertifolia | .25 | .91 | 20 | 10.00 |
| Atriplex powellii | .05 | .22 | 20 | 5.00 |
| Iva axillaris | .05 | .22 | 20 | 5.00 |
| Melilotus officinalis | 5.30 | 5.08 | 20 | 65.00 |
| Sanquisorba minor | 1.20 | 1.74 | 20 | 35.00 |
| Agropyron intermedium var. trichophorum | 23.20 | 8.87 | 20 | 100.00 |
| Bromus inerme | .50 | 1.54 | 20 | 10.00 |

(Data Sheet 5 of 5)

TABLE 11: 1987 monitoring results for the vegetation test plots of the Trail Mountain Coal Mine, Utah. The table shows a plant species list and the plot it was in. (Plot was sampled July 8, 1986).

| SCIENTIFIC NAME | COMMON NAME | SPECIES MIX |
|---|---|---|
| SHRUBS | | |
| Atriplex confertifolia | Shadscale | I |
| FORBS | | |
| Achillea millefolium | Yarrow | I |
| Astragalus cicer | Chickpea milkvetch | I |
| Maribium vulgare | Common horehound | II |
| Melilotus officinalis | Yellow sweet clover | I |
| Sanguisorba minor | Small burnet | II |
| GRASSES | | |
| Agropyron cristatum | | II |
| Agropyron trachycaulum | Slender wheatgrass | I |
| Agropyron intermedium var. trichophorum | Intermediate wheatgrass | II |
| Bromus carinatus | Mountain brome | I |
| Bromus inermis | Smooth brome | II |
| Bromus tectorum | June grass | II |
| Dactylis glomerata | Orchardgrass | II |
| Elymus cinereus | Gt. Basin wildrye | I |
| Hordeum jubatum | Foxtail | I |
| Oryzopsis hymenoides | Indian ricegrass | I |

(Data Sheet 1 of 5)

TABLE 12: 1987 SAMPLING RESULTS - SPECIES MIXTURE I

Total cover and composition of the revegetation test plots of the Trail Mountain Coal Mine. The table shows means, standard deviations and sample sizes.

COVER - SPECIES MIXTURE I

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE * |
|---|---|---|---|
| Total Living Cover | 69.75 | 10.06 | 20 |
| Erosion Mat | 12.55 | 8.82 | 20 |
| Bareground | 8.70 | 5.76 | 20 |
| Rock | 9.00 | 3.15 | 20 |

COMPOSITION - SPECIES MIXTURE I

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE * |
|---|---|---|---|
| Shrubs | 2.87 | 5.48 | 20 |
| Forbs | 4.98 | 8.15 | 20 |
| Grasses | 91.85 | 10.37 | 20 |

*Sample size insures 90% accuracy within 10% of the true mean.

(Data Sheet 2 of 5)

TABLE 13: 1987 SAMPLING RESULTS - SPECIES MIXTURE I

Mean percent cover, standard deviation, sample size and relative frequency by species of the revegetation test plots of the Trail Mountain Coal Mine.

SPECIES MIXTURE I

| SPECIES | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE | RELATIVE FREQUENCY |
|---|---|---|---|---|
| Atriplex confertifolia | 2.05 | 4.07 | 20 | 15.00 |
| Achillea millefolium | 2.10 | 4.67 | 20 | 25.00 |
| Astragalus cicer | 0.45 | 1.36 | 20 | 8.00 |
| Hedysarum boreale | 0.65 | 1.60 | 20 | 15.00 |
| Melilotus officinalis | 0.05 | 0.22 | 20 | 5.00 |
| Agropyron trachycaulum | 19.50 | 9.73 | 20 | 95.00 |
| Bromus carinatus | 20.05 | 11.69 | 20 | 100.00 |
| Elymus cinereus | 18.05 | 16.35 | 20 | 65.00 |
| Hordeum jubatum | 4.75 | 4.41 | 20 | 65.00 |
| Oryzopsis hymenoides | 1.85 | 3.61 | 20 | 25.00 |

(Data Sheet 3 of 5)

TABLE 14: 1987 SAMPLING RESULTS - SPECIES MIXTURE II

Total cover and composition of the revegetation test plots of the Trail Mountain Coal Mine. The table shows means, standard deviations and sample sizes.

COVER SPECIES MIXTURE II

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE |
|---|---|---|---|
| Total Living Cover | 60.90 | 8.77 | 20 |
| Erosion Mat | 17.85 | 8.99 | 20 |
| Bareground | 9.50 | 4.62 | 20 |
| Rock | 11.50 | 5.09 | 20 |

COMPOSITION - SPECIES MIXTURE II

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE* |
|---|---|---|---|
| Shrubs | -- | -- | 20 |
| Forbs | 2.33 | 5.48 | 20 |
| Grasses | 97.43 | 5.58 | 20 |

*Sample size insures 90% accuracy within 10% of the true mean.

(Data Sheet 4 of 5)

TABLE 15: 1987 SAMPLING RESULTS - SPECIES MIXTURE II

Mean percent cover, standard deviation, sample size and relative frequency by species of the revegetation test plots of the Trail Mountain Coal Mine.

SPECIES MIXTURE II

| SPECIES | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE | RELATIVE FREQUENCY |
|---|---|---|---|---|
| Maribium vulgare | 1.00 | 4.36 | 20 | 5.00 |
| Sanquisorba minor | 1.31 | 3.10 | 20 | 15.00 |
| Agropyron cristatum | 0.26 | 1.09 | 20 | 5.00 |
| Agropyron intermedium var. trichophorum | 44.31 | 19.05 | 20 | 100.00 |
| Bromus inermis | 9.19 | 10.87 | 20 | 50.00 |
| Bromus tectorum | 0.05 | 0.22 | 20 | 5.00 |
| Dactylis glomerata | 0.53 | 2.18 | 20 | 5.00 |

(Data Sheet 5 of 5)

TABLE 16: 1988 monitoring results for the vegetation test plots of the Trail Mountain Coal Mine, Utah. The table shows a plant species list and the plot it was in. (Plot was sampled August 26, 1988).

| SCIENTIFIC NAME | COMMON NAME | SPECIES MIX | |
|---|---|---|---|
| SHRUBS | | | |
| Atriplex confertifolia | Shadscale | I | II |
| FORBS | | | |
| Achillea millefolium | Yarrow | I | |
| Astragalus cicer | Chickpea milkvetch | I | |
| Erigeron sp. | Fleabane | I | |
| Eriogonum sp. | Buckwheat | | II |
| Grindelia squarrosa | Gumweed | | II |
| Hedysarum boreale | Northern sweetvetch | | II |
| Linum perenne | Wild flax | | II |
| Maribium vulgare | Common horehound | | II |
| Melilotus officinalis | Yellow sweet clover | I | |
| GRASSES | | | |
| Agropyron cristatum | Crested wheatgrass | I | II |
| Agropyron trachycaulum | Slender wheatgrass | I | |
| Agropyron intermedium var. trichophorum | Intermediate wheatgrass | | II |
| Bromus carinatus | Mountain brome | I | II |
| Bromus inermis | Smooth brome | | II |
| Elymus cinereus | Gt. Basin wildrye | I | II |

(Data Sheet 1 of 5)

TABLE 17: 1988 SAMPLING RESULTS - SPECIES MIXTURE I

Total cover and composition of the revegetation test plots of the Trail Mountain Coal Mine. The table shows means, standard deviations and sample sizes.

COVER - SPECIES MIXTURE I

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE * |
|---|---|---|---|
| Total Living Cover | 49.75 | 8.29 | 20 |
| Erosion Mat & Litter | 30.90 | 12.04 | 20 |
| Bareground | 11.70 | 6.78 | 20 |
| Rock | 7.65 | 6.64 | 20 |

COMPOSITION - SPECIES MIXTURE I

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE * |
|---|---|---|---|
| Shrubs | 2.63 | 10.88 | 20 |
| Forbs | 2.62 | 4.49 | 20 |
| Grasses | 94.76 | 11.20 | 20 |

*Sample size insures 90% accuracy within 10% of the true mean.

(Data Sheet 2 of 5)

TABLE 18: 1988 SAMPLING RESULTS - SPECIES MIXTURE I

Mean percent cover, standard deviation, sample size and relative frequency by species of the revegetation test plots of the Trail Mountain Coal Mine.

SPECIES MIXTURE I

| SPECIES | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE | RELATIVE FREQUENCY |
|---|---|---|---|---|
| SHRUBS | | | | |
| Atriplex confertifolia | 1.05 | 4.35 | 20 | 10.00 |
| FORBS | | | | |
| Achillea millefolium | 0.55 | 1.50 | 20 | 15.00 |
| Astragalus cicer | 0.20 | 0.60 | 20 | 10.00 |
| Erigeron sp. | 0.50 | 2.18 | 20 | 5.00 |
| Melilotus officinalis | 0.10 | 0.30 | 20 | 10.00 |
| GRASSES | | | | |
| Agropyron cristatum | 0.30 | 1.13 | 20 | 10.00 |
| Agropyron trachycaulum | 20.45 | 9.73 | 20 | 100.00 |
| Bromus carinatus | 1.00 | 3.00 | 20 | 10.00 |
| Elymus cinereus | 25.60 | 14.39 | 20 | 100.00 |

(Data Sheet 3 of 5)

TABLE 19: 1988 SAMPLING RESULTS - SPECIES MIXTURE II

Total cover and composition of the revegetation test plots of the Trail Mountain Coal Mine. The table shows means, standard deviations and sample sizes.

COVER SPECIES MIXTURE II

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE |
|---|---|---|---|
| Total Living Cover | 49.80 | 10.87 | 20 |
| Erosion Mat & Litter | 28.15 | 11.96 | 20 |
| Bareground | 8.75 | 5.52 | 20 |
| Rock | 13.30 | 9.06 | 20 |

COMPOSITION - SPECIES MIXTURE II

| | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE* |
|---|---|---|---|
| Shrubs | 0.42 | 1.82 | 20 |
| Forbs | 4.05 | 9.02 | 20 |
| Grasses | 95.06 | 9.02 | 20 |

*Sample size insures 90% accuracy within 10% of the true mean.

(Data Sheet 4 of 5)

TABLE 20: 1988 SAMPLING RESULTS - SPECIES MIXTURE II

Mean percent cover, standard deviation, sample size and relative frequency by species of the revegetation test plots of the Trail Mountain Coal Mine.

SPECIES MIXTURE II

| SPECIES | % MEAN COVER | STANDARD DEVIATION | SAMPLE SIZE | RELATIVE FREQUENCY |
|---|---|---|---|---|
| SHRUBS | | | | |
| Atriplix confertifolia | 0.25 | 1.09 | 20 | 5.00 |
| FORBS | | | | |
| Eriogonum sp. | 0.05 | 0.22 | 20 | 5.00 |
| Grindelia squarrosa | 0.25 | 1.09 | 20 | 5.00 |
| Hedysarum boreale | 0.05 | 0.22 | 20 | 5.00 |
| Linium perenne | 0.75 | 1.79 | 20 | 15.00 |
| Melilotus officinalis | 0.30 | 1.10 | 20 | 10.00 |
| GRASSES | | | | |
| Agropyron cristatum | 0.25 | 1.09 | 20 | 5.00 |
| Agropyron intermedium var. trichophorum | 42.40 | 14.02 | 20 | 100.00 |
| Bromus carinatus | 0.25 | 1.09 | 20 | 45.00 |
| Bromus inermis | 3.70 | 5.64 | 20 | 55.00 |
| Elymus cinerus | 1.55 | 2.60 | 20 | 45.00 |

(Data Sheet 5 of 5)

# REVIEW AND UPDATE OF THE SOIL SAMPLING PROGRAM

# REVIEW AND UPDATE OF THE SOIL SAMPLING PROGRAM AT THE TRAIL MOUNTAIN COAL MINE

by

Patrick D. Collins
November 1987

## INTRODUCTION

The purpose of this report is to first, review the soil sampling program at the Trail Mountain Coal Mine in Emery County, Utah. Extensive soil sampling has been implemented in the past as baseline information and for future reclamation planning of the coal mine. It was discovered by D. Duce [Division of Oil, Gas & Mining (DOGM)] and P. Collins (Mt. Nebo Scientific), that pertinent information about the soils that were previously submitted by the Trail Mountain Coal Mine, has been misplaced from the files of DOGM. This report will attempt to include copies of this information when it is pertinent for review of the soil sampling program and reclamation research at the mine. As part of this report, a review of the reasoning for the monitoring program and reclamation test plots will also be included.

Another objective of this report is to update the reviewer on data that has been recorded from the soils and vegetation since the Mining and Reclamation Plan (MRP) submittal. Additional soil/spoil analyses and vegetation sampling of the test plots has been accomplished at the mine site on a regular basis as a monitoring program.

## HISTORY AND RESULTS OF SOIL SAMPLING

To date, a total of 92 soil/spoil samples have been analyzed for chemical and physical characteristics on the relatively small disturbance area (approximately 8.8 acres) of the Trail Mountain Coal Mine.

### Phase I

In 1981, two soil pits were dug and 13 samples taken at regular intervals in native plant communities on the mine permit area to a depth of 5 ft. or bedrock (whichever came first). These samples were taken as one method to describe and classify the soils of the area (study done by VAUGHN HANSEN ASSOCIATES). Results from the study are described in Chapter VIII of MRP. EC values of these soils were also used in some of the statistical analyses described in the MRP and later in this report. The location of these soil pits are shown as numbers 36 and 37 of the enclosed map.

2 pits

### Phase II

Soil/spoil sampling was continued in 1983 by MT. NEBO SCIENTIFIC. At this time four more soil pits were dug and sampled at regular intervals to depths of 12 - 15 ft. on the disturbed areas of the Trail Mountain Coal Mine. Additional composite sampling was accomplished on native soils and disturbed spoils outside the soil pits. A total of 25 samples were taken and analyzed during Phase II. These samples were shown as numbers 1 - 25 on

4 soil pits

the map in Appendix 9 of the MRP (copy of this map is included in this report). These numbers also correspond to the numbers on Table 6 of Appendix 9 (copy also included) which are the lab results from the soils/spoils.

Results from the soil analyses indicated that there were some high SAR and EC values in an area adjacent to a sedimentation pond and where winter road salt was stored. These two factors (road salt and sedimentation) probable contributed to the high sodium in this area (Appendix 9, p.17-A, MRP). It was stated at that time that the soils/spoils of that area would "not be used as the topsoil substitute, but will be used as fill and buried to a depth of 4 feet."

Lab analysis results also indicated that there were EC values that were higher that 8 mmho/cm (Appendix 9,p.17-A, MRP). The mean EC value for the remainder of the spoil material (all spoils outside the road salt and sedimentation pond area in PhaseII) was only 8.3 mmhos/cm. EC values greater that 8 was the general criterion used by the regulatory authority to classify the soils as "poor". It is presently our opinion ( and was at that time) that: "there are several plant species that can tolerate these EC values, some of which were on the original tables of plant species for revegetation" (Appendix 9, p. 17-A, MRP). We also stated at that time that it was "our opinion that when these spoils are replaced to the proposed reclaimed slope, soil compaction will be greatly relieved in the mechanical process. Furthermore, water infiltration and soluble salt leaching will then occur" (Appendix 9, p. 17-B, MRP). This should reduce EC values significantly.

We then committed to yet another phase of the soil sampling program to further document EC, SAR, pH and texture of the mine disturbance areas for reclamation planning (Appendix 9, p.17-B, MRP).

Phase III

An additional soil sampling plan was designed by MT. NEBO SCIENTIFIC (P. Collins) and DOGM (E. Hooper, T. Portle). Four additional soil pits were sampled in 1984 at regular intervals to a depth of 10 ft. Additional surface and subsurface samples were also collected at that time to determine the extent of the salinity at the mine area (Appendix 9, p.17-D, MRP). Thirty-eight (38) native and disturbed soils were sampled and analyzed for chemical and physical characteristics in Phase III. Locations on the map and the results on Table 6 were numbered 26 - 34 (some locations had multiple samples varying in depth, see Table 6). A key to classify which soil samples were native soils and which were disturbed (spoils) was included in the MRP, pages 17-F, 17-G and 17-H. The sample numbers that were included also correspond to Table 6 of the MRP.

Further considerations of the results for the soil sampling of Phase II also suggest that the salinity will not be a problem for future revegetation of the Trail Mountain Coal Mine. Listed below are summaries of EC values from the soils analyzed in 1983 and 1984. Phase III summary is based on disturbed soils (spoils) only, and therefore excludes the native or undisturbed soils sampled at the same time.

MINE AREA EC VALUES (mmhos/cm)

| | Phase II (1983) | PhaseIII (1984) |
|---|---|---|
| Combined Soils (top and subsoils) | | |
| Mean EC | 10.80 | 8.95 |
| St.Dev | 8.84 | 2.65 |
| N | 25.00 | 22.00 |

As can be noted from that data above, additional sampling indicated lower mean EC values. The Phase II mean EC value was 10.80, whereas, Phase III mean value was 8.95, which falls within the Office of Surface Mining (OSM) guidelines of "eight, plus or minus one mmho/cm".

Phase IV

Six (6) topsoil and 10 subsoil samples were analyzed for comparisons in 1987 on the vegetation test plots. The soils used in the vegetation test plots were compared from the 1983 and 1987 data. When data of the test plots from the two years of combined soils, topsoil, and subsoil are compared, all EC values of 1987 were significantly less that 1983. The data are summarized below.

TEST PLOT SOILS EC VALUES

| | 1983 | 1987 |
|---|---|---|
| Combined Soils (top and subsoils) | | |
| Mean EC | 6.41 | 2.36 |
| St.Dev. | 1.29 | 1.05 |
| N | 6 | 16 |
| Topsoil | | |
| Mean EC | 6.70 | 1.25 |
| St.Dev. | 2.12 | 0.14 |
| N | 2 | 6 |

| | | |
|---|---|---|
| Combined Subsoil (all depths) | | |
| Mean EC | 6.19 | 3.67 |
| St.Dev. | 1.13 | 1.93 |
| N | 4 | 4 |
| Subsoil (18" -20") | | |
| Mean EC | 4.95 | 2.61 |
| St.Dev. | -- | 1.14 |
| N | 1 | 6 |

DISCUSSION

The data of Phase IV suggests that one of our original hypothesis may be valid: that when compaction of the spoils is relieved and water infiltration is enhanced, the soluble salts will leach to depths where they will not significantly influence successful revegetation. However, even if this hypothesis was incorrect, the plant species chosen for revegetation should establish successfully. To date, revegetation of the test plots has been very encouraging. For more information, about specific plot data, refer to Tables 1 - 15.

Vegetation Test Plots

Vegetation test plots were designed and implemented following Phase II and Phase III of the soil sampling program. The test plots at the Trail Mountain Mine were designed to address one main hypothesis: that existing soils/spoils of the mine area will provide a suitable medium for plant establishment at final reclamation. Final test plot designs including soils, plot sizes, plant species selection, methods, site preparations, seeding methods, sampling methods, plot monitoring and so forth were described in Appendix 9, p. 18-27, MRP. Results of the yearly monitoring program are included in this report on the aforementioned tables.

Test plot design and justifications were cited throughout the MRP based on experience in the area and results of the soil/spoil sampling and analyses. Several points and justifications should be reemphasized at this time concerning these vegetation test plots.

1) Because there was concern about the salinity of the spoils by OSM, and because all native undisturbed soils in the area are somewhat saline, we designed the test plots and reclamation techniques of the mine area with methods that should alleviate most soluble salt problems (i.e. testing the spoils material, using adapted and salt tolerant plant species, relieving compaction to increase water infiltration and salt leaching).

2) As noted above 1987 soil samples of the vegetation test plots indicated a significant decrease in salinity when compared to the values of 1983.

These preliminary results suggests that the original theoretical methods to decrease salinity may be valid for final reclamation.

3) It was also stated that if the test plots fail to show adequate success, the saline areas will be covered to a depth of at least 4 ft. by nonsaline spoil, followed by additional soil analyzed for verification (Appendix 9, p.17-B, 17-C MRP).

ADDITIONAL RESPONSES TO DOGM COMMENTS

UMC817.21-.26 (DD)

It was stated recently by DOGM that: "in order to fully address the implications of the sampling program, soil analysis of the test plot area must be undertaken as well. This will allow correlation of test plot revegetation success with soil chemical and physical characteristics, and validate test plot results with the reasoning behind OSM Condition #1. Please submit a sampling program and data collected to date on test plot, including a summary of any conclusions of findings."

The sampling program, theory, philosophy, results and reasoning behind the design of the vegetation test plots were described in detail above and in the MRP submitted to the regulatory agencies. Subsequent to the implementation of the test plots, OSM sent some Special Conditons. Special Condition No.1C stated that in the proposed test plots, "the surface six inches shall have a uniform EC vlaue of eight, plus or minus one mmho/cm, and the underlying 18 inches shall have a uniform EC value of 15, plus or minus two mmhos/cm". After reviewing the considerable amount of soil data, we found this design would not appropriately represent the conditions at the Trail Mountain Coal Mine. Firstly, when data from Phase I, II & III are examined, 87% of the spoils and 93% of the native soils analyzed had EC values less than 16 (plus of minus 2). Furthermore, if the sedimentation pond and road salt storage spoils are deleted (we have committed to burying these spoils), 94% of the soils have values less than 16 (plus of minus 2). Aside from these values not representing the soil conditions at the mine site, it would make it extremely impractical to locate and place spoils with these values in a test plot situation. It is our opinion that the methods implemented in the vegetation test plots at the Trail Mountain Mine is focused to address the most important and relevant question for successful future reclamation: Are the soils/spoils at the mine site adequate for

successful reclamation?

UMC 817.116 Revegetation: Standards for Success (KHM)

This sections states that "page 3-40 and Appendix 9, page 23, indicate that revegetation areas will be monitored annually by quantitetively sampling cover, density and production. There is no indication of where this data will be reported. This schedule includes more intensive sampling that seem necessary and, in terms of productivity, may be hazardous to the health of the revegetation".

The division (DOGM) then recommends the following schedule that is acceptable to the Trail Mountain Mine. The revised schedule for monitoring final revegetation will be a qualitative evaluation each year and quantitative sampling in years 2, 3, 5, 9 and 10 of the liability period which begins when revegetation, including maintenance activities, are completed. The monitoring data will be submitted in the form of an annual report to DOGM by April 1 the following year.

# SOIL MONITORING OF THE VEGETATIONAL TEST PLOTS

1987

# SOIL MONITORING OF THE VEGETATIONAL TEST PLOTS AT THE TRAIL MOUNTAIN COAL MINE - 1987

## INTRODUCTION

In 1983, samples were analyzed, taken the spoils to be used for the vegetation test plots at the Trail Mountain Coal Mine. These samples were taken prior to implementation of the test plots to enable researchers to monitor soil chemistry subsequent to their relocation. It is our contention that once spoils are placed on the reclaimed slopes, soil compaction will be relieved, enhancing both precipitation infiltration and leaching of soluble salts to levels that will not affect vegetation establishment.

Sampling of the same spoils, once they have been placed on a slope for the vegetation test plots, enables reseachers to monitor EC values as well as other chemical and physical characteristics of the spoils through time.

Results for the 1983 soil analyses were listed on Table 6, Appendix 9, of the MRP. Soil sample locations were also shown on the map in Appendix 9. Sample numbers for the spoils that correspond to the lab results and the map are: 1 - 5, and 23. Copies of Appendix 9 of the MRP that were submitted previously to DOGM, including tables and map, are included in this report to facilitate references.

## METHODS

Soil samples were taken on the vegetation test plot in August and September of 1987. A total of 16 topsoil and subsoil samples were taken and analyzed for physical and chemical characteristics at the soils laboratory at Brigham Young University.

Topsoils of the test plots were analyzed for the following characteristics: 1) nitrogen, 2) phosphorus, 3) potassium, 4) organic matter, 5) sodium absorption ratio (Ca, Mg, Na), 6) pH, 7) EC, 8) cation exchange capacity, 9) texture (% sand, silt, clay), 10) % moisture, and 11) carbonates. Subsoil analyses were limited to 1) pH, 2) texture (%sand, silt, clay), 3) EC, and 4) sodium absorption ratio.

The samples were taken (at a depth of 6 inches) by stratified random methods, insuring adequate representation of the entire test plots. The six topsoil samples were composite samples (each samples was taken by mixing soils from three locations). Six subsoil samples were taken at depth of 18 inches. Because it was necessary for the mine to disturb a small portion of the test plot by drilling, we were also able to take subsoil samples at regular intervals to a depth of 8 ft.

## RESULTS

Results of all soil analyses for 1987 are given on the following pages. Because the previous soil sampling results are also included in this report, cross-referencing can easily be done.

# Brigham Young University

## Department of Agronomy & Horticulture

## Soil Analysis Data

Submitted By :: Mt. Nebo Scientific - Patrick Collins
Address :1230 N. 270 E.
CSZ :Springville,Utah 84663

Date :10-16-1987
Sample Description :soil

| Customer Sample ID | PH | %Sand | %Clay | %Silt | Ec x 10^3 |
|---|---|---|---|---|---|
| 1 Pit MI #7,2' | 7.90 | 34.72 | 26.56 | 38.72 | 2.75 |
| 2 Pit, MI #8,4' | 8.30 | 34.00 | 29.28 | 36.72 | 2.90 |
| 3 Pit, MI #9,6' | 8.40 | 38.00 | 25.28 | 36.72 | 2.48 |
| 4 Pit, MI #10,8' | 8.10 | 22.72 | 34.56 | 42.72 | 6.55 |

NOTES

Pit = Soil pit sample
MI = Mixture I
MII = Mixture II
#7 = Field sample number
2' = Sample depth (2 ft.)
Top = Topsoil sample (6 in. depth)
87 = 1987
Sub = Subsoil sample (18 in. depth)

# Brigham Young University

## Department of Agronomy & Horticulture

## Soil Analysis Data

Submitted By :: Mt. Nebo Scientific - Patrick Collins
Address :1230 N. 270 E.
CSZ :Springville,Utah 84663

Date :10-16-1987
Sample Description :soil

| Customer Sample ID | PPM Ca | PPM Mg | PPM Na | SAR |
|---|---|---|---|---|
| 1 Pit MI @7,2' | 140.48 | 253.44 | 232.00 | 2.69 |
| 2 Pit, MI @8,4' | 91.84 | 133.12 | 400.00 | 6.21 |
| 3 Pit, MI @9,6' | 112.00 | 204.80 | 176.00 | 2.27 |
| 4 Pit, MI @10,8' | 448.80 | 614.40 | 528.00 | 3.78 |

# Brigham Young University
## Department of Agronomy & Horticulture
## Soil Analysis Data

Submitted By :Mt. Nebo Scientific - Patrick Collins
Address :1230 N. 270 E.
CSZ :Springville, Utah 84663

Date :09-15-1987
Sample Description :soil

| Customer Sample ID | PPM P | PPM NO3-N | PPM K-AV | %OM | PPM Ca |
|---|---|---|---|---|---|
| Top M1 #1 87 | 47.20 | 1.99 | 160.00 | 4.45 | 147.20 |
| Top M1 #2 87 | 18.68 | 2.83 | 147.20 | 3.45 | 116.16 |
| Top M1 #3 87 | 14.63 | 1.23 | 144.00 | 2.99 | 106.72 |
| Top M11 #1 87 | 141.78 | 0.69 | 131.20 | 2.63 | 124.32 |
| Top M11 #2 87 | 17.47 | 1.44 | 112.00 | 3.96 | 94.56 |
| Top M11 #3 87 | 308.07 | 2.27 | 195.20 | 3.85 | 146.08 |

# Brigham Young University
## Department of Agronomy & Horticulture
## Soil Analysis Data

Submitted By :Mt. Nebo Scientific - Patrick Collins
Address :1230 N. 270 E.
CSZ :Springville, Utah 84663

Date :09-15-1987
Sample Description :soil

| Customer Sample ID | PPM Mg | PPM Na | PH | Ec x 10^3 | CEC meq/100g |
|---|---|---|---|---|---|
| Top MI #1 87 | 115.20 | 42.40 | 7.7 | 1.26 | 14.27 |
| Top MI #2 87 | 84.48 | 35.04 | 7.8 | 1.14 | 13.92 |
| Top MI #3 87 | 97.28 | 71.04 | 7.7 | 1.34 | 13.44 |
| Top MII #1 87 | 110.08 | 44.48 | 7.8 | 1.32 | 13.75 |
| Top MII #2 87 | 69.12 | 52.16 | 7.9 | 1.03 | 13.70 |
| Top MII #3 87 | 112.64 | 41.12 | 7.6 | 1.40 | 14.75 |

# Brigham Young University
## Department of Agronomy & Horticulture
## Soil Analysis Data

Submitted By :Mt. Nebo Scientific - Patrick Collins
Address :1230 N. 270 E.
CSZ :Springville, Utah 84663

Date :09-15-1987
Sample Description :soil

| Customer Sample ID | SAR | %Sand | %Silt | %Clay | %N |
|---|---|---|---|---|---|
| Top M1 #1 87 | 0.63 | 37.28 | 37.44 | 25.28 | 0.11 |
| Top M1 #2 87 | 0.60 | 38.00 | 34.72 | 27.28 | 0.11 |
| Top M1 #3 87 | 1.19 | 39.28 | 35.44 | 25.28 | 0.11 |
| Top M11 #1 87 | 0.70 | 38.56 | 35.44 | 26.00 | 0.07 |
| Top M11 #2 87 | 0.99 | 43.28 | 31.44 | 25.28 | 0.11 |
| Top M11 #3 87 | 0.62 | 36.56 | 35.44 | 28.00 | 0.10 |

# Brigham Young University
## Department of Agronomy & Horticulture
## Soil Analysis Data

Submitted By :Mt. Nebo Scientific - Patrick Collins
Address :1230 N. 270 E.
CSZ :Springville, Utah 84663

Date :09-15-1987
Sample Description :soil

| Customer Sample ID | %Moisture | %CaCO3 | Texture |
|---|---|---|---|
| Top MI #1 87 | 33.91 | 52.39 | Loam |
| Top MI #2 87 | 31.84 | 52.67 | Clay Loam |
| Top MI #3 87 | 32.48 | 54.28 | Loam |
| Top MII #1 87 | 32.20 | 51.87 | Loam |
| Top MII #2 87 | 32.35 | 49.92 | Loam |
| Top MII #3 87 | 35.29 | 54.62 | Loam |

# Brigham Young University
## Department of Agronomy & Horticulture
## Soil Analysis Data

Submitted By :Mt. Nebo Scientific - Patrick Collins
Address :1230 N. 270 E.
CSZ :Springville, Utah 84663

Date :09-15-1987
Sample Description :Soil

| Customer Sample ID | PH | Ec x 10^3 | PPM Ca | PPM Mg | PPM Na |
|---|---|---|---|---|---|
| Sub MI #4 87 | 7.9 | 3.02 | 146.24 | 238.08 | 250.88 |
| Sub MI #5 87 | 7.4 | 2.45 | 173.76 | 207.36 | 143.36 |
| Sub MI #6 87 | 8.3 | 1.49 | 111.84 | 79.36 | 145.92 |
| Sub MII #4 87 | 7.7 | 3.52 | 113.76 | 225.28 | 366.08 |
| Sub MII #5 87 | 7.8 | 1.13 | 71.04 | 71.68 | 89.76 |
| Sub MII #6 87 | 7.6 | 4.05 | 150.08 | 302.08 | 427.52 |

# Brigham Young University
## Department of Agronomy & Horticulture
## Soil Analysis Data

Submitted By :Mt. Nebo Scientific - Patrick Collins
Address :1230 N. 270 E.
CSZ :Springville, Utah 84663

Date :09-15-1987
Sample Description :Soil

| Customer Sample ID | SAR | %Sand | %Silt | %Clay | Texture |
|---|---|---|---|---|---|
| Sub M1 #4 B7 | 2.96 | 32.56 | 40.16 | 27.25 | Clay Loam |
| Sub M1 #5 B7 | 1.73 | 34.56 | 39.44 | 26.00 | Loam |
| Sub M1 #6 B7 | 2.57 | 48.56 | 31.44 | 20.00 | Loam |
| Sub M11 #4 B7 | 4.55 | 32.56 | 39.44 | 28.00 | Clay Loam |
| Sub M11 #5 B7 | 1.79 | 38.56 | 35.44 | 26.00 | Loam |
| Sub M11 #6 B7 | 4.60 | 36.00 | 36.72 | 27.28 | Clay Loam |

# APPENDIX 3-10-1

# WILDLIFE RESOURCE STUDY

# APPENDIX 10-1

# WILDLIFE RESOURCE STUDY OF TRAIL MOUNTAIN

state of utah

# DIVISION OF WILDLIFE RESOURCES

DOUGLAS F. DAY
*Director*

EQUAL OPPORTUNITY EMPLOYER

1596 West North Temple/Salt Lake City, Utah 84116/801-533-9333

May 22, 1981

Reply To SOUTHEASTERN REGIONAL OFFICE
455 West Railroad Avenue, Box 840, Price, Utah 84501
(801) 637-3310

Natomas Trail Mountain Coal Company
Trail Mountain Mine
Orangeville, Utah

Dear Sirs:

I want to take this opportunity to extend thanks for the assistance personnel at your mine have provided our staff in becoming familiar with existing and planned surface facilities on the area encompassed by Natomas Trail Mountain Coal Company's Trail Mountain Mining Project. I believe that you will find the enclosed information helpful at filing a mine and reclamation plan.

In response to your request for wildlife resource information (UMC 783.20) the attached map, data and comments are provided. The wildlife resource information is consistent with the formal guidelines for acquisition of fish, wildlife and habitat information provided your Company by Utah's Division of Oil, Gas and Mining. In instances where your Company was required to provide for study beyond existing information, such findings need be merged with our report.

Please note that the enclosed wildlife plan (UMC 784.21) represents our recommendations; Utah's Division of Oil, Gas and Mining is the regulatory authority for approval of the mining and reclamation plan. Implementation of the recommended wildlife plan should assist the Company in compliance with performance standards UMC 817.97.

Thank you for an opportunity to assist your Company in complying with the State's permanent program for coal mining and reclamation and the resultant protection of Utah's wildlife resources. If the Division can be of any further service, please coordinate with our Regional Resource Analyst (Larry Dalton, phone 801-637-3310) as appropriate.

Sincerely,

John Livesay, Supervisor
Southeastern Region

JL:LBD:gp

Attachment

cc: Darrell Nish
Clark Johnson
Cleon B. Feight

RECEIVED JUN 1 1981

GOVERNOR
Scott M. Matheson

DEPT. OF NATURAL RESOURCES
Gordon E. Harmston
Exec. Director

WILDLIFE BOARD
Roy L. Young — Chairman
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UMC 783.20; FISH AND WILDLIFE RESOURCE INFORMATION
NATOMAS TRAIL MOUNTAIN COAL COMPANY, TRAIL MOUNTAIN MINING PROJECT

General Wildlife Resource Information--All Species of Vertebrate Wildlife

The mine plan area encompasses a portion of the Wasatch Plateau in Emery County, Utah. This area drains into the Straight Canyon-Cottonwood Creek drainage and on into the San Rafael River, which flows into the Green River and ultimately into the Colorado River at a point upstream from Lake Powell. Generally speaking, the Wasatch Plateau is encompassed by cold desert (upper Sonoran life zone), submontane (Transition life zone) and montane (Canadian, Hudsonian and Alpine life zones) ecological associations. These life zones could be inhabited on occasion and during different seasons of the year by about 364 species of vertebrate wildlife--14 fish species, 6 amphibian species, 18 reptile species, 242 bird species and 84 mammal species. It is interesting to note that 83 percent of these species are protected.

The mine plan area itself is represented by the Transition and Canadian life zones and provides habitat for approximately 245 species of wildlife--8 fish species, 6 amphibian species, 17 reptile species, 140 bird species and 74 mammal species. Sixty-one of these species are of high interest to the State of Utah.

The Division Publication No. 78-16 "Species List of Vertebrate Wildlife That Inhabit Southeastern Utah" is appended (Appendix A) to this report since it represents a low level of study for the wildlife species listed. It identifies those species having potential to inhabit the region as well as those inhabiting the environs of the mine plan area. Appendix A also identifies which species are considered to be of high interest for the habitats and local area represented.

High interest wildlife are defined as all game species; any economically important species; and any species of special aesthetic, scientific or educational

significance. This definition would include all federally listed, threatened and endangered species of wildlife.

A ranking and display of wildlife habitats and use areas relative to high interest species of vertebrate wildlife has been developed (Table 1 and 2 and the attached map). Critical wildlife use areas followed in respective importance by high-priority, substantial value and limited value wildlife use areas require various levels of protection from man's activities and developments. Wildlife habitats and use areas are ranked as being of critical or high-priority value to wildlife should be protected from surface disturbance, subsidence impacts and human or industrial disturbance. This can be accomplished through development and implementation of a wildlife plan.

Critical wildlife use areas are "sensitive use areas" necessary to sustain the existence and perpetuation of one or more species of wildlife during crucial periods in their life cycles. These areas are restricted in area and lie within high-priority wildlife use areas. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 1 or 2 are classified as being critical. Biological intricacies dictate that significant disturbances cannot be tolerated by the members of an ecological assemblage on critical sites. Professional opinion is that disturbance to critical use areas or habitats will result in irreversible changes in species composition and/or biological productivity of an area.

High-priority wildlife use areas are "intensive use areas" for one or more species of wildlife. "Intensive use areas" are not restricted in area and in conjunction with limited value use areas form the substantial value distribution for a wildlife species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 3 are classified as being of high-priority. In addition, wildlife use areas where surface disturbance or

underground activities may result in subsidence that could interrupt underground aquifers and result in a potential for local loss of ground water and decreased flows in seeps and springs should be considered as being of high-priority to wildlife.

Substantial value wildlife use areas are "existence areas" for one or more species of wildlife. "Existence areas" represent a herd or population distribution and are formed by the merging of high-priority and limited value wildlife use areas for a species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 4 are classified as being of substantial value.

Limited value wildlife use areas are "occasional use areas" for one or more species of wildlife. "Occasional use areas" are part of the substantial value wildlife use area for a species. All stream sections, reservoirs, lakes and ponds identified by Utah Division of Wildlife Resources as Class 5 or 6 are classified as being of limited value.

## MAPPING

### Vegetation and Wildlife Habitats

It is recommended that the Company's primary effort be placed on identifying species of vegetation in each wildlife habitat within the various wildlife use areas for purposes of reclamation. The Division does not have site specific information relative to vegetation types at the mine plan area. However, there are nine wildlife habitats present--riparian or wetland types, cliffs and talus, sagebrush, pinion-juniper forest, shrubland, aspen forest, ponderosa forest, parkland and spruce-fir forest. The Company should identify each of these habitat associations on appropriately scaled maps.

It is believed that if satisfactory reclamation is achieved and man's disturbance does not continue or become a factor, that most species of wildlife dis-

placed from the mine plan area will return. Without doubt, the key to success for enhancing or restoring wildlands will be development of habitats so that the postmining condition as compared to the premining condition will have similar species, frequency and distribution of permanent plants in each vegetative type this will allow for natural plant succession. Additionally, other habitat features that represent the various life requirements for local wildlife must be provided.

Wildlife Use Areas

The enclosed map displays mapable, high value use areas for high interest wildlife on or adjacent to the mine plan area. This display includes stream sections and bodies of water, if any, utilized by high interest fish species. Also displayed are know seeps, springs, wetlands, and riparian zones. Note that there are high interest wildlife distributions that are so broad that they cover the entire map and therefore are not illustrated. However, all vertebrate species of high interest wildlife and their distributions are discussed in the follcwing narrative.

Water

Due to demands of state and federal coal mining regulations, the Company will probably be required to identify and appropriately monitor all surface waters for potential impacts from subsidence. This information should be correlated with the wildlife use area information due to the value of water to wildlife.

FISH AND WILDLIFE INVENTORY

Aquatic Use Areas

Macrophytes

From a position of the aquatic wildlife resource it is believed that there is no practicality for information relative to macrophytes to be addressed by the mine permit application; such information is not generally available.

Macroinvertebrates

The results from studies of macroinvertebrates may be required for purposes of determining need for stream buffer zones (UMC 817.57) in stream sections supporting biological communities. Since historic impacts from this mine's operation are evident in Cottonwood Creek data relative to macroinvertebrates as a pollution index or a forage base for fishes or other predators dependent upon the aquatic resource need be presented.

Note, impact avoidance procedures that would protect the integrity of the aquatic resource need to be included with the mine permit application. Of importance would be facility designs and operational plans that will preclude further impacts on this stream and identification of procedures that will be utilized to keep any form of coal sediments or other pollution from entering Cottonwood Creek and ultimately reaching Straight Canyon Creek. Snow removal is a significant contribution of sediments to local riverine systems. Deposition of coal particles in the aquatic system could have a variety of negative impacts on invertebrate and fish populations.

The results from long-term studies of macroinvertebrates in Cottonwood Creek would be of value for the Company to demonstrate when impacts that resulted from accumulations of coal and other sediments in this creek have ceased. Other sediments have resulted from encroachment of the road upon Cottonwood Creek. These accumulations of sediments will likely continue until coal particles cease to enter the creek and the encroachment problems eleviated.

Studies relative to macroinvertebrates if desired or needed, must be conducted by a qualified, private consultant.

Fish--Species Occurrence and Use Areas

Aquatic habitats associated with the mine plan area support three species of game and five species of nongame fish; all of which are protected. Of these fish, four species have been determined to be of high interest to Utah (Appendix A and

reference the Division Publication No. 78-16).

The yellowstone cutthroat trout is an introduced species. It annually spawns between early May and mid-July. Most populations are sustained through natural reproduction; hatching is usually completed by mid-July.

The rainbow trout is an exotic species. Within Utah there are several different strains of this species. Generally speaking they spawn from mid-March through June; hatching is normally completed by late June. It is important to note that natural reproduction by this species is almost non-existent, since it is managed as a stocked population. This management scheme has resulted since their catchability is higher than other trout and the life expectancy of hatchery fish is short.

The brown trout is an exotic species. Its spawning period begins as early as mid-October and is normally completed by late December; hatching of eggs begins in the spring and is usually completed by late May. Most populations are sustained through natural reproduction and supplemental plantings of fingerling brown trout.

The spawning period represents a crucial period for maintenance of trout populations; spawning areas are ranked as being of critical value. Such areas are characterized by clean, gravel zones that are at least six inches deep. These zones must also be covered by a minimum of six inch deep water flowing at a velocity of not less than one foot per second. These physical parameters are necessary for optimum spawning success.

Once the cutthroat or rainbow trout have spawned their eggs incubate in the redds approximately 30 to 50 days--water temperatures ranging from 45 to 50 F. Brown trout eggs incubate throughout the winter which lasts approximately 100 to 150 days--water temperatures ranging from 35 to 40 F. During this crucial period water temperature affects the rate of embryonic develop—the warmer the water the more quickly incubation is completed. It is also during this period

that ongoing sedimentation can result in suffocation of the eggs. Fluctuations in stream flow also negatively affects incubation; wherever practicable, maintenance of a constant flow of water during the spawning period enhances reproductive success.

The mottled sculpin is a native species. It annually spawns in the spring between February and May. All of their populations are sustained through natural reproduction. The spawning period represents a crucial period for maintenance of sculpin population; spawning areas (nest) are ranked as being of critical value. Such areas for sculpin are characterized as a nest scooped out beneath a stone or other submerged object. Spawning areas must have clean, gravel or rubble zones. Both the adult fish attend and defend the nest. They are known to spawn in water temperatures ranging from 45 to 48 F.

The reach of Straight Canyon Creek that receives flow from Cottonwood Creek and lies proximal to the project area (stream section 2) is ranked as being of high-priority to Utah's cold water fishery management program and is a Class 3 fishery. It supports natural reproduction of self-sustaining cutthroat and brown trout populations. Occasionally, fingerling transplants of both of these species supplement the population. Some of the trout in this stream section are hatchery planted, catchable sized rainbow trout. Section 2 of Straight Canyon Creek is also inhabited by speckled dace, mottled sculpin and mountain, bluehead and flannelmouth suckers.

Although there are no fish in Cottonwood Creek, its flow of water is of great value for reproductive success of spawning trout in section 2 of Straight Canyon Creek for which it is a tributary water. Additionally, drift of macroinvertebrates from this stream represent an important contribution of forage to trout and other fishes in Straight Canyon Creek.

If project operations are planned or develop that would alter, destroy or discharge polluting effluents into any perennial waters, appropriate state and federal permits, a mitigation plan and results from high level studies of the

salmonid fishery resource, if any, would be required of the Company. Achievement of mitigation would demand detailed studies of stream velocity correlated to flow, representatives of the stream channel profile, gradient, pool-riffle ratio, substrata types identifying percent representation of each type and surface water information required for SMC 779.16.

If modification of flows is anticipated, instream flow requirements must be considered to meet the needs of the existing fisheries, "biological community" and maintenance of existing riparian or wetland zones. Such baseline information would allow for development of mitigation or reclamation plans that would allow for avoidance, lessening or mitigation of impacts to the fishery and maintenance or re-establishment of unique habitat types. This baseline information is not generally available and would necessitate the services of a qualified private consultant and/or contracting Utah's Division of Wildlife Resources since special permits would be required.

It is important to note that no species of fish having relative abundances so low as to have caused them to be federally listed as threatened or endangered inhabit the mine plan or adjacent areas. The endangered humpback chub, bonytail chub and Colorado squawfish inhabit the Green and Colorado Rivers. Additionally, the humpback (razorback) sucker also inhabits those rivers; it is likely that this species will one day be federally listed as threatened. It is not believed that implementation and operation of the Company's project will impact any of these species.

Terrestrial Use Areas

Wildlife Habitat Types

Of the nine wildlife habitat types present on the mine plan area wetlands and riparian habitats are ranked as being of critical value to all wildlife. Such zones are normally associated with drainage bottoms (ephemeral or intermittent), or perennial streams (UMC 700.5), seeps and springs within the upper Sonoran,

Transition and Canadian life zones. Cliffs and their associated talus areas that lie within the upper Sonoran and Transition life zones are ranked as being of high-priority value to all wildlife. When compared to all other wildlife habitats the aforementioned situations are considered to represent unique habitat associations (Table 1).

Riparian and wetland areas are highly productive in terms of herbage produced and use by wildlife as compared to surrounding areas. Experience has shown that as much as 70 percent of a local wildlife population are dependent upon riparian zones. Cliffs and tallus are of special importance to many high interest wildlife. These unique habitat types must be identified in the permit application and protected due to their high value for all wildlife.

Quantitative (acreage) and qualitative (condition, successional stage and trend) data concerning the wildlife habitats in each ecological association should be included as part of the mine permit application. It is important to note that each legal section of land represented by the mine plan and adjacent areas has been ranked as to its value for the total wildlife resource. Sections 24, 25, 26, and 35 of Township 17 South Range 6 East have been ranked as being of critical value to wildlife. This is also true for Sections 19 and 20 of Township 17 South Range 7 East. Sections 23 and 36 of Township 17 South Range 6 East have been ranked as being of high-priority value to wildlife. This is also true for Section 36 of Township 17 South Range 7 East. These rankings were developed through an analysis of cumulative values for use areas of individual wildlife species inhabiting each legal section of land (Table 2).

Amphibians--Species Occurrence and Use Areas

Six species of amphibians, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that all of these species inhabit the project area (reference the Division Publication No. 78-16). Only one species of the amphibians inhabiting the project area have been determined to be of high interest to the State of Utah (Appendix A).

The tiger salamander is a yearlong resident animal of the project area. The substantial value use area for the adult form is represented by any moist underground site or any similar habitat such as inside rotten logs, cellars or animal burrows. Such sites can be found within any wildlife habitat extending from the cold desert (upper Sonoran life zone) through the submontane (Transition life zone) and into the montane (Canadian life zone) ecological association. The larva form, often referred to as a mud-puppy, is a gilled animal that must remain in water within the above described ecological associations. It is interesting to note that the larva may fail to transform into an adult, even after their second season, and they can breed in the larva condition.

Once the larva is transformed into the adult form the animal is primarily terrestrial. Salamanders do migrate to water in the spring for breeding and may remain there during much of the summer. Such an intensive use area would be ranked as being of high-priority value to the animal. In September the newly transformed animals leave the water to find suitable places to spend the winter.

The tiger salamander breeds from March through June and is sexually mature after one year. The male deposits a small tent-shaped structure containing a myriad of sperm on the pool bottom. During courtship the female picks up this structure in her cloaca; then the eggs are fertilized internally before or just at the time they are laid. The eggs, singly or in small clusters, adhere to submerged vegetation; after 10 to 12 days they hatch. Obviously, a critical period for maintenance of the population is when breeding salamanders, eggs or their larva are inhabiting a water.

Post-embryonic development of a salamander's larval form progresses at a pace somewhat controlled by water temperature; in some cold waters the larva may not transform into an adult and drying up of a pool may hasten the process.

Migration to or from water usually occurs at night, during or just after a rain storm. When inhabiting terrestrial sites the tiger salamander is most active

at night, particularly on rainy nights, from March through September.

Larva, when small feed on aquatic invertebrates and become predacious to the point of cannibalism when they are larger. Food items for adults include insects, earthworms and occasionally small vertebrates.

No amphibians have relative abundances that are so low to have caused the animal to be federally listed as a threatened or endangered species.

Reptiles—Species Occurrence and Use Areas

Eighteen species of reptiles, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that seventeen of these species inhabit the project area (Reference the Division Publication No. 78-16). Only two species of the reptiles inhabiting the project area have been determined to be of high interest to the State of Utah (Appendix A).

The Utah milk snake is a yearlong resident animal of the project area. Its substantial value use area encompasses all wildlife habitats extending from the upper Sonoran (cold desert life zone) through the submontane (Transition life zone) and into the montane (Canadian and possibly Hudsonian life zone) ecological associations. Although its use area spans a multitude of habitats, the animal is extremely secretive, mostly nocturnal and is often found inside or under rotten logs, stumps, boards, rocks or within other hiding places. At night they can be found in the open where they hunt for small rodents, lizards and other small snakes. Occasionally, the milk snake may take small birds or bird eggs.

The milk snake may live beyond twenty years and it becomes sexually mature during its third spring season. After mating, which occurs during spring or early summer when they are leaving the den, female milk snakes produce clutches which average seven eggs. The eggs are secreted in a moist warm environ and then abandoned; incubation lasts 65 to 85 days. The site where an individual snake has

deposited its clutch of eggs is of critical value to maintenance of the species.

The Utah mountain kingsnake is a yearlong resident animal of the project area. Its substantial value use area encompasses all wildlife habitats extending from the submontane (Transition life zone) into the montane (Canadian and possibly Hudsonian life zones) ecological association. Little is known concerning this animal except that it frequents areas of dense vegetation and that it is often found near water. Its life history and food habits parallel that described for the Utah milk snake.

To date snake dens, which are protected and of critical value to snake populations, have not been identified on or adjacent to the project area. It is important to note that inventory for such has not been attempted. If the Company at some later time discovers a den it should be reported to the Utah Division of Wildlife Resources. If a den(s) is currently known, its location must be included with the permit application.

No reptiles have relative abundances that are so low to have caused the animal to be federally listed as a threatened or endangered species.

Birds--Species Occurrence and Use Areas

Two hundred forty-two species of birds, all of which are protected, are known to inhabit the biogeographic area in which the mine plan and adjacent areas are located. It is probable that one hundred fourty of these species inhabit the project area (Reference the Division Publication No. 78-16). Twenty-nine species of the birds inhabiting the project area have been determined to be of high interest to the State of Utah (Appendix A).

Ducks commonly known as waterfowl are not known to utilize the project area, but may on occasion or during different seasons of the year make limited use of the riparian area. All of these species are of high interest to the State of Utah (Appendix A). Generally speaking, the riparian and wetland habitats encompassed

by the project and adjacent areas provide substantial valued habitats for waterfowl. Each species has different life requirements and makes various uses of the riparian and wetland habitats.

For those waterfowl that nest locally, the period March 15 through July 15 is ranked as being of crucial value to maintenance of the population. Following incubation, which dependent upon the species may vary between 20 and 28 days and extend up until mid-August, the riparian and wetland habitats represent a high-priority brooding area. Additionally, the wetland habitat (large open water areas or dense marshland, none of which exist on the project area) is of high-priority for seclusion and protection of adult waterfowl during their flightless period when they moult. Males may begin the moult in early June and both sexes and the young are capable of flight by mid-August.

The project and adjacent areas provides substantial valued habitat for a multitude of raptors--turkey vulture, bald and golden eagles, four species of falcons (prairie, American and arctic peregrine falcons and American kestrel), five species of hawks (goshawk, sharp-shinned, Cooper's, red-tailed and Swainson's hawks) and seven species of owls (barn, screech, flammulated, great horned, pygmy, long-eared and saw-whet owls). Many of these species are of high federal interest pursuant to 43 CFR, 3461.1 (n-1). All of these species are of high interest to the State of Utah (Appendix A).

Realistically, nesting habitat does not exist on the project or adjacent areas for many of these species. However, if a species were to nest on or adjacent to the project area, it would have a specific crucial period during which the aerie would need protection from disturbance; this period of time lies between February 1 and August 15. Generally speaking, aeries represent a critical valued site and need protection from significant or continual disturbance within a one-half kilometer radius of the nest. This consideration need only be implemented during

the period of time that the nest is occupied. Species specific protective stipulations for aeries are available from the Utah Division of Wildlife Resources and the U.S. Fish and Wildlife Service.

The current level of data relative to site specific use of the area by raptors is unsatisfactory. Likely, there are aeries that have not been identified. Many of these species are highly sensitive to man's disturbances. Therefore, it is recommended that intensive surveys be initiated on the mine plan and adjacent areas for determination of locations for raptor aerie territories. Such data needs to be merged with information provided within this report.

Golden eagles are a common yearlong resident of the mine plan area. There are no known active aerie territories associated with the project. (Note, an aerie territory is utilized by one pair of eagles but may contain several nest sites).

It is believed that aerie territories for eagles may exist on the project area. This belief is based upon the fact that suitable nesting habitat is widespread on the mine plan area and throughout the local area. It is important to note that the regularity of golden eagle observations and the fact that their status is common has resulted in documentation of mostly opportunistic observations of aerie territories.

An active golden eagle nest site is extremely sensitive to disturbance within a one-half kilometer radius. This buffer zone is ranked as being of critical value to maintenance of the eagle population when the bird is actually utilizing the aerie; that period of time is normally between April 15 and June 15. The radius for a buffer zone may need to be increased to one kilometer if a disturbance were to originate from above and within direct line of sight to the eagle aerie.

To date there are no known high-priority concentration areas or critical roost trees for golden eagles on the project area. The mine plan and adjacent

areas have been ranked as being of substantial value to golden eagles.

The northern bald eagle is an endangered winter resident (November 15 to March 15) of the local area. To date there are no known high-priority concentration areas or critical roost trees for this species on or adjacent to the project. The mine plan area has been ranked as being of substantial value to wintering bald eagles. Note that no bald eagles are known to nest in Utah, however, historic data documents nesting activity by these birds in the State. There is no known historic evidence of the northern bald eagle nesting on the mine plan or adjacent areas.

The American peregrine falcon (relative abundance is endangered) and the prairie falcon (relative abundance is common) are yearlong residents of the mine plan and adjacent areas. Each of these species utilizes cliff nesting sites. To date there are no known aerie sites for cliff nesting falcons on the project area. However, suitable nesting habitat for the prairie falcon is widespread. Suitable nesting habitat for the American peregrine falcon cannot be found on the mine plan and adjacent areas. Since existence on the area by prairie falcons would not be unlikely, the project area has been ranked as being of substantial value to this cliff nesting falcon. However, the project area only is ranked as being of limited value to peregrine falcons.

For each falcon their aerie site while being utilized and a one-half kilometer radius would be ranked as being of critical value to maintenance of their populations. The falcon's period of use at the aerie site spans the spring and early summer period--prairie falcon, April 15 to June 30; peregrine falcon, March 1 to June 30.

The level of data relative to site specific use of the project area by cliff nesting falcons (not including the kestrel) is unsatisfactory and there could be aeries that have not been identified. Therefore, it is recommended that intensive surveys be initiated on the area for determination of locations for cliff falcon

aerie sites.

The endangered arctic peregrine falcon is a winter resident (November 15 through March 15) of the local area. This species has not been observed to utilize the environs on or adjacent to the mine plan area, however, its occasional presence would not be unlikely. Therefore, the project area is ranked as being of limited value to this species.

The blue grouse is a yearlong resident of the project area. Adult birds prefer open stands of conifers. During winter the blue grouse feeds exclusively upon needles and buds of douglas-fir and spruce trees. Thus, this wildlife habitat (spruce-fir forest) is ranked as being of critical value to over-winter survival of the population during the crucial period of December through February.

Blue grouse annually exhibit what has been termed a reverse vertical migration. That is, during the spring months, they migrate from the high elevation spruce-fir habitat to lower elevation sagebrush, pinion-juniper or shrubland habitats. This movement is caused by a need of the birds to feed on early developing vegetation. Such movement also facilitates successful breeding, nesting and brooding of their young. Then as the year progresses, they move to the higher elevations.

The males are polygamous and will set up and defend territories for booming and breeding activities against other breeding males. Such territories are critical to maintenance of the population during the crucial period of mid-March through mid-June.

After breeding the female develops a nest site which is secreted on the ground; the nest is of critical value to maintenance of the blue grouse population. Upon hatching, which occurs in late May and early June, the young accompanied by the hen immediately leave the nest. The young blue grouse while being brooded rely heavily on insects for their protein needs during the first several months

of development. The adult bird also shifts its diet during this period to include a high proportion of insects. Brooding areas are ranked as being of high-priority value to blue grouse. The crucial period extends from hatching into mid-August.

As summer progresses into the fall season the grouse consumes large quantities of berries.

The ruffed grouse is a yearlong resident of the project area. These grouse are usually found in the continum of habitats extending from aspen to shrubland types. But, during winter they often roost in dense stands of conifers. Generally speaking ruffed grouse prefer habitats lying with 0.25 mile of a stream course; such areas are ranked as being of high-priority value to their population. During winter the ruffed grouse feeds exclusively upon staminate aspen buds. Thus, this wildlife habitat (aspen forest) is ranked as being of critical value to over-winter survival of the population during the crucial period of December through February. During the remainder of the year their diet shifts to include a wide variety of plant and insect material.

Ruffed grouse do not exhibit any type of seasonal migration.

The males are polygamous and will set up and defend territories against other breeding males. The focal point for breeding activity is the drumming log; all such logs are ranked as being of critical value to grouse since they represent sites of historical use. Such territories are critical to maintenance of the population during the crucial period of early March through May.

After breeding the female develops a nest site which is secreted on the ground and deep within an aspen grove; the nest is of critical value to maintenance of the ruffed grouse population. Upon hatching, which occurs in late May and early June, the young accompanied by the hen immediately leave the nest. The young ruffed grouse while being brooded rely heavily on insects for their protein needs during the first several months of development. The adult bird

also shifts its diet during this period to include a high proportion of insects. Brooding areas are ranked as being of high-priority value to ruffed grouse. The crucial period for brooding extends from hatching into mid-August.

The band-tailed pigeon is a summer resident of the project area. This bird is seldom observed to utilize the Wasatch Plateau, but when observed the species is only represented by a single bird, pairs or even less frequently a small flock. Since the band-tailed pigeon's use of the Wasatch Plateau is best described as "occasional", the environs associated with the project are only ranked as being of limited value to the bird. Nesting birds secret their nest in trees within the spruce-fir wildlife habitat. Peak on-nest activity occurs in late July and early August.

Mourning doves normally inhabit the project and adjacent areas, which represents a substantial valued use area for these birds, between May 1 and September 15 each year. They nest throughout most of this period and each pair produces two clutches. The pinion-juniper and riparian habitats are ranked as being of high-priority value for nesting. Locally, mourning doves show two peaks in on-nest activity--early July and early August. Successful nesting activities and any water sources are critical to maintenance of the mourning dove population.

The yellow-billed cuckoo is a summer resident of the project area. This bird only nests in the riparian wildlife habitat, therefore, such areas are of critical value to maintenance of this species. Little is known concerning the yellow-billed cuckoo. Its nest is represented by a frail, saucer shaped structure of twigs and is always placed in bush or tree.

The black swift is a summer resident of the Wasatch Plateau. The montane ecological association represents the swift's substantial valued use area. Normally, the bird is associated with a small flock that represents a colony. Black swifts are usually observed soaring as pairs and they feed upon flying insects. A colony's nests are scattered along percipitous terrain where the nest is often

secreted behind a waterfall. Such a moist habitat is not known to exist on the project area. Cliff and tallus wildlife habitats are ranked as being of high-priority value to the black swift. There is evidence that pair bonds are long lasting and that a nest may be utilized in successive years.

The belted kingfisher is a yearlong resident of the project area. It is found only along riverine systems and its substantial value use area extends from the cold desert through the submontane and into the montane ecological associations. Therefore, the riparian wildlife habitat represents a high-priority valued use area for this bird. It feeds exclusively upon fish. The kingfisher's nest is always secreted within a burrow along stream banks, thus, dirt bank habitats along riparian areas are of critical value to this bird.

The pileated woodpecker is a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). The spruce-fir and aspen wildlife habitats of the montane ecological association represent this birds substantial valued use area. It is important to note that the pileated woodpecker has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where the bird is known to exist, it is a yearlong resident with a relative abundance considered to be rare.

The Williamson's sapsucker is another species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Typically, the substantial valued use area for this species is the spruce-fir habitat of the Hudsonian life zone in the montane ecological association. Therefore, the spruce-fir habitat of the Canadian life zone on the project site would only represent the substantial valued use area for the yellow-bellied sapsucker. The yellow-bellied sapsucker is a yearlong resident of the environs associated with the project area and it has a relative abundance considered to be common. Where as the Williamson's sapsucker has never

been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where the Williamson's sapsucker is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

The Lewis woodpecker is also another species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use area is represented by riparian habitats characterized by cottonwood stands and ponderosa forests. These habitats do not exist on the project site. It is important to note that the Lewis woodpecker has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where the bird is known to exist, it is a summer resident or only a transient. Its relative abundance is unknown.

The purple martin is a summer resident known to inhabit the environs of the biogeographic area that surrounds the project site. In Utah its substantial valued use area is represented by open spruce-fir, aspen or ponderosa forest habitats of the montane ecological association. The purple martin feeds on flying insects and may secret its nest within any suitable above-ground cavity.

The western bluebird is an uncommon summer resident known to inhabit the environs of the biogeographic area that surrounds the project site. Where as the mountain bluebird is a common yearlong resident of the area. Both birds are cavity nesting species. The western bluebird nests from the pinion-juniper habitat of the submontane ecological association up into the lower forest habitats within the Canadian life zone of the montane ecological association. The mountain bluebird utilizes the same continum of habitats for nesting, but also extends its nesting use across the Canadian and Hudsonian life zones and into the Alpine life zone. During winter both species show elevational and longitudinal migrations; they then utilize all habitats associated with the cold desert ecological association. Therefore, the substantial valued use area for each species spans a

broad continum of habitats. It is important to note that trees with cavities located on the project area can be of critical value to bluebirds.

Grace's warbler is a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use area is shrublands and associated ponderosa forest habitats of the submontane and montane ecological associations. This bird's nest is built twenty or more feet above ground in a ponderosa tree. It is important to note that the Grace's warbler has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where it is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

Scott's oriole is also a species having high federal interest pursuant to 43 CFR 3461.1 (n-1). Its substantial valued use areas are riparian habitats characterized by cottonwood stands and the continum of habitats extending from the pinion-juniper forest into shrublands of the submontane ecological association. The oriole's nest is characterized as a grassy pouch and is hung in a tree. It is important to note that the Scott's oriole has never been documented to utilize the environs of the biogeographic area that surrounds the project site. In areas of the State where it is known to exist, it is a summer resident with a relative abundance considered to be uncommon.

Mammals--Species Occurrence and Use Areas

Eighty-four species of mammals, of which 25 percent are protected, are known to inhabit the biogeographic area in which the project and adjacent areas are located. It is probable that seventy-four of these species inhabit the project area (Reference the Division Publication No. 78-16). Twenty-six species of the mammals inhabiting the project area have been determined to be of high interest to the State of Utah (Appendix A).

The red bat is a summer resident of the biogeographic area that surrounds the project site. The animal roosts in wooded areas (riparian woods and pin-

ion-juniper forests) of the submontane ecological association. Such areas represent this animals substantial valued use area. An occasional individual has been known to utilize caves; those individuals could hibernate and remain over winter.

The western big-eared bat is a yearlong resident of the biogeographic area that surrounds the project site. This animal roosts and hibernates within caves, mine tunnels or suitable buildings located in the pinion-juniper, shrubland and low elevation spruce-fir habitats of the submontane and montane (Canadian life zone) ecological association. Such areas represent this bats substantial valued use area.

The snowshoe hare is a yearlong resident of the biogeographic area that surrounds the project site. Its relative abundance has been determined to be limited, since its substantial valued use area is restricted to the spruce-fir and nearby aspen and riparian habitats of the montane (Canadian and Hudsonian life zones) ecological association. Such areas are ranked as being of high-priority value to the animal during its breeding season which spans the period between early April and mid-August.

The cottontail rabbit (mountain cottontail inhabits sites lying between 7,000 and 9,000 feet in elevation and the desert cottontail inhabits sites lower than 7,000 feet in elevation) is a yearlong resident of the biogeographic area that surrounds the project site. The entire project area represents a substantial valued use area for cottontails. Their young are born between April and July. This is a crucial period for maintenance of the cottontail population.

The northern flying squirrel is a yearlong resident of the biogeographic area that surrounds the project site. Currently, its relative abundance is unknown. Its substantial valued use area is restricted to spruce-fir or other mixed conifer habitats of the montane (Canadian and Hudsonian life zones) ecological association.

This specie is the only nocturnal squirrel in Utah. The flying squirrel may build its nest within an old woodpecker hole or it may build an outside nest of leaves, twigs and bark. Mating occurs twice in each year--February through March and June through July. Afterwhich, two to six young are born after a gestation period of 40 days--April through May and August through September. These periods are of crucial value to maintenance of their populations. During winter flying squirrels are gregarious; 20 or more have been known to den together.

Beaver are yearlong inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area is restricted to riparian and adjacent aspen habitats (those located within 100 meters of the riparian zone) in the cold desert, submontane and montane (Canadian life zone) ecological associations. These animals construct a conical shaped lodge in which a family group lives throughout the year. The lodge is of critical value to maintenance of the beaver population. One litter of kits is produced each year; they are born between late April and early July after a gestation period of 128 days. Kits and yearlings coinhabit the lodge with the adult pair. When they attain 2 years of age they are forced to leave; females can breed at 2.5 years of age. Due to the animals dependency upon flowing water and the associated riparian vegetation, the riparian wildlife habitat is ranked as being of critical value to beaver populations.

The red fox is a yearlong inhabitant of the biogeographic area that surrounds the project site. The substantial valued use area for the red fox would include all wildlife habitats extending from the cold desert through the montane (Canadian life zone) ecological associations. Almost nothing is known of their population dynamics. Without doubt a crucial period for this specie is when they are caring for young in the den. Dens while being inhabited are a critical use area.

The gray wolf is a historic inhabitant of the biogeographic area that sur-

is restricted to the Canadian life zone; where as the mink utilize the Canadian and Hudsonian life zones.

The substantial valued use area for marten and wolverine is the montane ecological association. The marten does not utilize the Alpine life zone but the wolverine can be found at that elevation. Both species could be found in the environs of the project site.

The substantial valued use area for badger and skunks span all wildlife habitats other than dense forests in the cold desert, submontane and montane (Canadian life zone) ecological associations. Skunks show some afinity for habitats proximal to water. Skunks and badgers are dependent upon a suitable prey source.

A crucial period for maintenance of all furbearers, raccoons and muskrat populations is when they have young in a nest, den or lodge. Such sites are critical for reproductive success.

Bobcat, Canada lynx and cougar are known to inhabit the biogeographic area that surrounds the project site. For all of these species a crucial period for maintenance of their population is when the female has her young secreted at a den site. Such sites are of critical value when being utilized. It is also crucial to their survival that a female accompanied by young not be killed or harassed.

The substantial valued use area for bobcats extends from the cold desert through the submontane and into the montane (Canadian life zone) ecological association. The bobcat is normally associated with percipitous terrain, but has been observed in every wildlife habitat within the aforementioned ecological associations. Their primary prey source is represented by small mammals and birds or any other small animal they can catch. It is important to note that bobcats occasionally do kill the young of big game animals.

The substantial valued use area for the Canada lynx is restricted to the

Canadian and Hudsonian life zones of the montane ecological association. Normally, this cat would only be expected to utilize riparian and forested wildlife habitats. The lynx is similar in predation habits to the bobcat.

The substantial valued use area for the cougar (locally known as mountain lion) extends from the submontane into the montane (Canadian and Hudsonian life zone) ecological association. Due to the dependency of the cougar upon mule deer as a prey source, a ranking of the lion's seasonal distribution parallels that of the deer.

Mule deer are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats extending from the cold desert through the submontane and montane ecological associations. In some situations deer show altitudinal migrations in response to winter conditions. There are, however, habitats where deer reside on a yearlong basis (see attached map).

Migration of mule deer from summer range to winter range is initiated during late October; probably, the annual disturbance of the fall hunting season coupled with changing weather conditions is the initial stimulus. The onset of winter weather reinforces the deer's urge to migrate and continued adverse weather keeps the deer on the winter range.

A portion of the project site represents winter range for mule deer herd Unit 35. Winter ranges for mule deer are all ranked as being of high-priority value to the animal; these areas are usually inhabited between November 1 and May 15 each year. During winters with severe conditions the higher elevation portion of the winter range becomes unavailable to deer due to snow depth. Traditionally, some restricted portions of the winter range have shown concentrated use by the deer; these sites are ranked as being of critical value. It is important to note that all of the canyon bottoms associated with the project are of critical value to deer. Critical valued sites must be protected from

man's disturbance when the deer are physically present on the range.

Deer begin their migration back to summer range during mid-May and remain there throughout October. Summer ranges on the project area represent deer herd Unit 35. They are ranked as being of high-priority value to mule deer. In instances where extent of summer range is the major limiting factor for a deer herd, those summer ranges are ranked as being of critical value.

There are ranges that support mule deer on a yearlong basis. Most of these ranges are of limited value to deer. However, there are some areas supporting yearlong use that are ranked as being of high-priority value to deer. There are no yearlong ranges for mule deer on the project site.

Mule deer fawn during the month of June. The continum of wildlife habitats extending from the pinion-juniper through the shrubland and into the aspen type probably represents the fawning area. All riparian areas are of critical value for fawning and maintenance of the deer population. To date no specific areas showing annual use for fawning are known. It is probable that such areas exist; they would be ranked as being of critical value to deer. It is important to note that June represents a crucial period for maintenance of deer populations.

Agriculture areas that are bisected by the access route to the project area are utilized yearlong by mule deer. Their use is sometimes intensified during the winter and spring periods.

Moose are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats in the montane ecological association except those associated with the Alpine life zone. In some situations moose show altitudinal migrations in response to winter conditions. There are, however, habitats where moose reside on a yearlong basis (see attached map).

Migration of moose from summer range to winter range is initiated during late November; probably, changing weather conditions is the initial stimulus.

The onset of winter weather reinforces the moose's urge to migrate and continued adverse weather keeps the animal on the winter range.

The project site represents substantial valued, yearlong range for the Southeastern Utah moose herd—Joe's Valley drainage. Seasonal use areas for moose proximal to the project have not yet been established. On a regional basis winter ranges for moose that are characterized as riparian habitats are ranked as being of critical value, where as the remainder of the winter ranges are ranked as being of high-priority value to the animal. Winter ranges are usually inhabited by moose between December 1 and May 15 each year. During winters with severe conditions the higher elevation portion of the winter range becomes unavailable to moose due to snow depth. Critical valued sites must be protected from man's disturbance when the moose are physically present on the range.

Moose begin their migration back to summer range during mid-May and remain there throughout November. Summer ranges are ranked as being of high-priority value.

Moose calf during late May and June. Calving takes place in the riparian or adjacent forest habitats. Generally speaking, all riparian areas that have demonstrated preference for use by moose are of critical value for calving and maintenance of their population. To date no specific areas proximal to the project and showing annual use for calving are known. If such areas did exist, they would be ranked as being of critical value to moose. It is important to note that June represents a crucial period for maintenance of moose populations.

Rocky mountain elk are inhabitants of the biogeographic area that surrounds the project site. Their substantial valued use area spans all wildlife habitats

extending from the submontane through the montane ecological association. Elk do not show as strong of altitudinal migration as mule deer do in response to winter conditions, but they do migrate to wintering areas (see attached map).

Migration of elk from summer range to winter range is initiated during late October; probably, the annual disturbance of the fall hunting seasons coupled with changing weather conditions is the initial stimulus. The onset of winter weather reinforces the elk's urge to migrate and continued adverse weather keeps elk on the winter range.

A portion of the project site represents winter range for the Manti elk herd--Unit 12. Winter ranges for elk are all ranked as being of high-priority value to the animal; these areas are usually inhabited between November 1 and May 15 each year. During winters with severe conditions some portions of the winter range becomes unavailable to elk due to snow depth. Traditionally, some restricted portions of the winter range have shown concentrated use by the elk; these sites are ranked as being of critical value. The high ridges associated with the project are critical winter ranges for elk. Critical valued sites must be protected from man's disturbance when the elk are physically present on the range.

Elk begin their migration back to summer range during mid-May and remain there throughout October. Summer ranges on the project area support the Manti elk herd--Unit 12; they are ranked as being of high-priority value.

Elk calf during the month of June. Their preferred calving areas are best described as aspen forests with lush understory vegetation. All riparian areas on the summer range are of critical value for calving and maintenance of the elk population. To date no specific areas showing annual use for calving are known. It is probable that such areas exist; they would be ranked as being of critical value to elk. It is important to note that June represents a crucial period for maintenance of elk populations.

Currently, there are no other known high interest wildlife species or their habitat use areas on or adjacent to the project area. It is not unreasonable to suspect that in the future, some additional species of wildlife may become of high interest to the local area, Utah or the Nation. If such is the case, the required periodic updates of project permits and reclamation plans can be adjusted and appropriate recommendations made.

APPENDIX 3-10-2

WILDLIFE HABITAT RANKING

# APPENDIX 10-2

# WILDLIFE HABITAT RANKING

Table 2. Ranking of wildlife value per legal section of land on coal producing lands in Utah. Crucial-critical (1), sections are the highest valued followed in respective order by high-priority (2), substantial value (3) and limited valued (4) sections.

BOOK CLIFFS

| T. | R. | Section | Rank |
|---|---|---|---|
| 12 | 8 | 1-36 | 1 |
| 12 | 9 | 2,4-12,14,16-18,31-35 | 1 |
| | | 1,3,13,15,19-30,36 | 2 |
| 12 | 10 | 2-11,13-17,19-27 | 1 |
| | | 1,12,18,28-36 | 2 |
| 12 | 11 | 16-28,33-35 | 1 |
| | | 1-15,29-32,36 | 2 |
| 12 | 12 | 19,27-30,32-34 | 1 |
| | | 1-18,20-26,31,35,36 | 2 |
| 13 | 8 | 1-3,5-16,19,20,22-24,28-31 | 1 |
| | | 4,17,18,21,25-27,32-36 | 2 |
| 13 | 9 | 1-11,14,15,17,18,28,29,31-35 | 1 |
| | | 12,13,16,19-27,30,36 | 2 |
| 13 | 10 | 1,2,6 | 1 |
| | | 3-5,7-36 | 2 |
| 13 | 11 | 14-16,21-28,34-36 | 1 |
| | | 1-13,17-20,29-33 | 2 |
| 13 | 12 | 4,19,30,31,[illegible] | 1 |
| | | 1-3,5-18,20-29,32-35 | 2 |
| 13 | 13 | 1-36 | 2 |
| 14 | 13 | 1-36 | 2 |
| 14 | 14 | 33 | 1 |
| | | 1-32,34-36 | 2 |
| 15 | 14 | 1-21,23-26,28-36 | 2 |
| | | 22,27 | 3 |
| 16 | 14 | 24-26,35,36 | 1 |
| | | 1-23,27-34 | 2 |
| 16 | 15 | 3,10,11,14,23-25,29-33 | 1 |
| | | 1,2,4-9,12,13,15-22,26-28,34-36 | 2 |
| 17 | 14 | 1,12,13,24,25,36 | 1 |
| | | 2,3,10,11,14,15,22,23,26,27,34, 35 | 2 |
| 17 | 15 | 4-9,16-22,27-34 | 1 |
| | | 1-3,10-15,23-26,35,36 | 2 |
| 18 | 14 | 1,27 | 1 |
| | | 2,3,10-15,22-26,34-36 | 2 |
| 18 | 15 | 4-10,15-18 | 1 |
| | | 1-2,11-14,19,21-25,30-32 | 2 |
| | | 3,20,26-29,33-36 | 3 |

HENRY MOUNTAINS

| T. | R. | Section | Rank |
|---|---|---|---|
| 27 | 9 | 1-36 | 1 |
| 30 | 9 | 25,32-36 | 3 |
| | | 19-24,26-31 | 4 |
| 30 | 10 | 20-29,32-36, | 1 |
| | | 19,30,31 | 3 |
| 31 | 8 | 1,7,12,13,18,19,24,25,30,31,36 | 3 |
| | | 2-6,8-11,14-17,20-23,26-29,32-35 | 4 |
| 31 | 9 | 4-9,16-21,28-33 | 3 |
| 32 | 8 | 30,31 | 2 |
| | | 1,6,7,10-15,18,20-29,33-36 | 3 |
| | | 2-5,8,9,16,17,19,32 | 4 |
| 32 | 9 | 1,12,13,24,25,35,36 | 1 |
| | | 2-11,14-23,26-34 | 3 |
| 33 | 8 | 6-8,12-14,17-20,22-36 | 2 |
| | | 1-4,9-11,15,16 | 3 |
| | | 5,21 | 4 |
| 33 | 9 | 1-3,9-17,20-28,34-36 | 1 |
| | | 7,18,19,29-32 | 2 |
| | | 4-6,8,33 | 3 |
| 34 | 8 | 1-3,10-13,15 | 2 |
| | | 14 | 3 |
| 34 | 9 | 3 | 1 |
| | | 2,5-11,13,14,16-19 | 2 |
| | | 1,4,12,15,20-24,26-28 | 3 |
| | | 25,29-36 | 4 |
| 34 | 10 | 1-23,26-30,32-34,36 | 2 |
| | | 24,25,35 | 3 |
| | | 31 | 4 |

KAIPAROWITS PLATEAU

| T. | R. | Section | Rank |
|---|---|---|---|
| 33 | 1 | 26,27,34-36 | 1 |
| | | 25,33 | 2 |
| | | 19-25,29-32 | 3 |
| 33 | 2 | 28,31-33 | 1 |
| | | 19-21,29-30 | 3 |
| 34 | 1 | 1-3,10-14,24 | 1 |
| | | 4-9,15-23,25-36 | 2 |
| 34 | 2 | 4-7,17,18,20,21,28,29 | 1 |
| | | 8,9,16,19,30-33 | 2 |
| 35 | 2W | 3-10,16-19 | 1 |
| | | 2,11,14,15,20-23,27-32 | 2 |
| | | 1,12,13,24-26,33-36 | 3 |

KAIPAROWITS PLATEAU (CONTINUED)

| T. | R. | Section | Rank |
|---|---|---|---|
| 35 | 1 | 1-34 | 2 |
| | | 35-36 | 3 |
| 35 | 2 | 4-9,16-20,25 | 2 |
| | | 21-24,26-36 | 3 |
| 35 | 3 | 30-32 | 2 |
| | | 19-29,33-36 | 3 |
| 36 | 3W | 1-3,10-12,14,15 | 2 |
| | | 13 | 4 |
| 36 | 2W | 1-6,8-12 | 3 |
| | | 7,13-18,22-27,34-36 | 4 |
| 36 | 1W | 36 | 1 |
| | | 1,24-26,35 | 2 |
| | | 2-23,27-34 | 3 |
| 36 | 1 | 4-9,19-36 | 2 |
| | | 1-3,10-18 | 3 |
| 36 | 2 | 30,31 | 2 |
| | | 1-29,32-36 | 3 |
| 36 | 3 | 5,8,17,20,21,27,28,33-35 | 2 |
| | | 1-4,6,7,9-16,18,19,22-26,29-32, 36 | 3 |
| 37 | 1W | 1,2,11-14,23-26,35,36 | 2 |
| | | 3-10,15-22,27-34 | 3 |
| 37 | 1 | 1-36 | 2 |
| 37 | 2 | 6,7,12,13,17-20,24,25,29-32,36 | 2 |
| | | 1-5,8-11,14-16,21-23,26-28, 33-35 | 3 |
| 37 | 3 | 1,2,6-9,12,15-23,25-36 | 2 |
| | | 3-5,10,11,13,14,24 | 3 |
| 37 | 4 | 20,21,28-33 | 2 |
| | | 19 | 3 |
| 38 | 1W | 1-3,11-14 | 2 |
| | | 4-10,15-18 | 3 |
| 38 | 1 | 1-18,22-27,34-36 | 2 |
| 38 | 2 | 17 | 1 |
| | | 1,4-9,12,13,16,18-21,24,25,28-33, 36 | 2 |
| | | 2,3,10,11,14,15,22,23,26,27,34, 35 | 3 |
| 38 | 3 | 1-36 | 2 |
| 38 | 4 | 2-36 | 2 |
| | | 1 | 4 |
| 38 | 5 | 19-22,26-36 | 2 |
| | | 23-25 | 4 |
| 39 | 1 | 1-18,22-27,34-36 | 2 |
| 39 | 2 | 1,2,4-9,11-20,22-36 | 2 |
| | | 3,10,21 | 3 |
| 39 | 3 | 1-36 | 2 |
| 39 | 4 | 1-36 | 2 |
| 39 | 5 | 1-36 | 2 |
| 40 | 2 | 1-36 | 2 |
| 40 | 3 | 1-36 | 2 |
| 40 | 4 | 1-36 | 2 |
| 40 | 5 | 1-36 | 2 |
| 40 | 6 | 4-9,16-21,28-33 | 2 |
| 41 | 2 | 1-30 | 2 |
| | | 31-36 | 3 |
| 41 | 3 | 31-36 | 1 |
| | | 1-21,29,30 | 2 |
| | | 22-28 | 3 |
| 41 | 4 | 31-36 | 1 |
| | | 1-17,20-28 | 2 |
| | | 18,19,29,30 | 3 |
| 41 | 5 | 31-33 | 1 |
| | | 1-9,11-14,18,23-26,35,36 | 2 |
| | | 10,15-17,19-22,27-30,34 | 4 |
| 42 | 1W | 13-36 | 1 |
| | | 4,9 | 2 |
| | | 1-3,5-8,10-12 | 4 |
| 42 | 3 | 1-36 | 1 |
| 42 | 4 | 1-36 | 1 |
| 42 | 5 | 2-36 | 1 |
| | | 1 | 2 |
| 43 | 3 | 1-11,14-18 | 1 |
| | | 12,13 | 4 |

WASATCH PLATEAU NORTH

| T. | R. | Section | Rank |
|---|---|---|---|
| 12 | 6 | 1-26,29,31,34-36 | 1 |
| | | 27,28,30,32,33 | 2 |
| 12 | 7 | 1-15,17-36 | 1 |
| | | 16 | 3 |
| 12 | 8 | 1-36 | 1 |
| 13 | 6 | 1,2,5-8,10,13,17-20 | 1 |
| | | 3,4,9,11,12,14-16,21-36 | 2 |
| 13 | 7 | 1-4,9-17,19,22-26,31,32,35,36 | 1 |
| | | 5-8,18,20,21,27-30,33,34 | 2 |
| 13 | 8 | 1-3,5-16,19,20,22-24,28-31 | 1 |
| | | 4,17,18,21,25-27,32-36 | 2 |

WASATCH PLATEAU NORTH (CONTINUED)

| T. | R. | Section | Rank |
|---|---|---|---|
| 14 | 6 | 28-33 | 1 |
| | | 1-27,34-36 | 2 |
| 14 | 7 | 1,4-6,9,12,13,16 | 1 |
| | | 2,3,7,8,10,11,14,15,17-36 | 2 |
| 15 | 6 | 4-6,10-15,22-24 | 1 |
| | | 1-3,7-9,16-21,25-36 | 2 |
| 15 | 7 | 32-36 | 1 |
| | | 1-31 | 2 |
| 15 | 8 | 9,15,20-22,27-29,32,33 | 1 |
| | | 1-8,10-14,16-19,23-26,30,31,34-36 | 2 |
| 16 | 6 | 11,13,14,16,20-26,28,29,31-33,35, 36 | 1 |
| | | 1-10,12,15,17-19,27,30,34 | 2 |
| 16 | 7 | 1-5,9-16,21-28,34-36 | 1 |
| | | 6-8,17-20,29-33 | 2 |
| 16 | 8 | 4,7,9,17-21,28-31 | 1 |
| | | 1-3,5,6,8,10-16,22-27,32-36 | 2 |
| 17 | 6 | 4-9,11-14,16-22,24-35 | 1 |
| | | 1-3,10,15,23,36 | 2 |
| 17 | 7 | 1,2,7,12,18,19,25,30 | 1 |
| | | 3-6,8-11,13-17,20-24,26-29,31-36 | 2 |
| 17 | 8 | 5,6,16,19 | 1 |
| | | 4,7-9,17,18,20,21,28-33 | 2 |
| 18 | 6 | 1-3,10,11,13-15,22-27,34-36 | 1 |
| | | 12 | 2 |
| 18 | 7 | 4,5,7-11,13-17,19-27,29-32,34-36 | 1 |
| | | 1-3,6,12,18,28,33 | 2 |
| 19 | 6 | 1-3,10-15,22-27,34-36 | 1 |
| 19 | 7 | 1-3,5,23,27-34 | 1 |
| | | 4,24-26,35,36 | 2 |

WASATCH PLATEAU SOUTH

| T. | R. | Section | Rank |
|---|---|---|---|
| 20 | 5 | 20-29,31-36 | 1 |
| | | 19,30 | 2 |
| 20 | 6 | 19-36 | 1 |
| 21 | 4 | 1-3,10-15,19-36 | 1 |
| | | 4-9,16-18 | 2 |
| 21 | 5 | 1-36 | 1 |
| 21 | 6 | 4-9,16-21,28-33 | 1 |
| 22 | 3 | 1-3,10-15,22-27,34-36 | 1 |
| 22 | 4 | 1-4,9-16,21-28,33-36 | 1 |
| | | 5-8,17-20,29-32 | 2 |
| 22 | 5 | 1-20,22-24,29-30 | 1 |
| | | 21,25-28,31-36 | 2 |
| 23 | 3 | 1,12,13 | 1 |
| | | 2,3,10,11,14,15,22-27 | 2 |
| | | 34-36 | 3 |
| 23 | 4 | 2-4,6-11,14-18,20-29,31-36 | 1 |
| | | 1,5,12,13,19,30 | 2 |
| 24 | 4 | 2,4-9,16-18 | 1 |
| | | 1,3,10-15 | 2 |

This Table represents a summation of work published in 1977 as a "Ranking of Wildlife Values on Federal Coal Lands". Robert W. Scott performed the work as a Division of Wildlife Resources employee under contract (No. 14-16-006-3125) for the U.S. Fish and Wildlife Service. Scott's procedure ranked habitat use areas as critical, high-priority, substantial and limited value for select individual species of high interest. Afterwhich the individual values were evaluated per legal section of land and a cummulative value was determined.

the state of Utah. Crucial-critical (C) habitats are the highest valued followed in respective order by high-priority (H), substantial value (S) and limited valued (L) habitats.

| Ecological Association | Wildlife Habitats | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Riparian and Wetland | Desert Scrub | Pasture and Fields | Urban or Parks | Cliffs and Tallus | Sagebrush | P-J Forest | Shrubland | Aspen Forest | Ponderosa Forest | Parkland | Spruce-fir Forest |
| **LOWER SONORAN LIFE ZONE** | | | | | | | | | | | | |
| Warm Desert | This ecological association does not exist in the Southeastern Region | | | | | | | | | | | |
| **UPPER SONORAN LIFE ZONE** | | | | | | | | | | | | |
| Cold Desert C($H^1$, $S^2$) | S | | S | S | H | | | | | | | |
| **TRANSITION LIFE ZONE** | | | | | | | | | | | | |
| Submontane C($H^1$, $S^2$) | | | S | S | H | S | S | S | | | | |
| **CANADIAN LIFE ZONE** | | | | | | | | | | | | |
| Montane C($H^1L^2$) | | | S | L | S | | | | S | S | S | S |
| **HUDSONIAN LIFE ZONE** | | | | | | | | | | | | |
| Montane H($S^1$; $L^2$) | | | | | S | | | | | | | S |
| **ALPINE LIFE ZONE** | | | | | | | | | | | | |
| Montane | This ecological association does not exist in the Southeastern Region | | | | | | | | | | | |

This Table represents a summation of effort where by numerical values were assigned as a ranking per high interest specie to each wildlife habitat. The numerical values were as follows: critical, 1; high-priority, 2; substantial, 3; and limited, 4. Once the individual values were assigned they were then summed and a mean calculated, for each wildlife habitat. A mean value lying between 1.0 and 1.8 was ranked as critical; a value between 1.9 and 2.3 was ranked as high-priority; a value between 2.4 and 3.4 was ranked as substantial; and a value between 3.5 and 4.0 was ranked as limited.

1. Habitat ranking value for species associated with the riparian-wetland type that represents just the wet meadow situation.
2. Habitat ranking value for species associated with the riparian-wetland type that represents just the dirt bank situation.

Figure 1. Key for mapable, high-value habitat use areas for wildlife.

| Wildlife Use Areas | Use Area Ranking | | |
|---|---|---|---|
| | Substantial-Value | High-Priority[2] | Crucial-Critical[2] |
| | | Aquatic Use Areas | |
| Stream Sections and Lakes[1] | [s-cw-2-4-yl] | [h-cw-2-3-yl] | [c-cw-2-1-yl] |
| | | Terrestrial Use Areas | |
| Wetlands, Riparian Zones, Seeps and Springs | | | |
| Bison | Herd Distribution s-b-yl | | Winter Range c-b-wt 12-1 to 4-15<br>Summer Range c-b-su 4-15 to 11-30 |

[1] Streams: The first letter (c) identifies one of the four use areas ranking--c, crucial-critical; h, high-priority; s, substantial value; l, limited value. The second group of letters (cw) identifies the primary type of fishery for which a water is managed--cw, cold water fishery; ww, warm water fishery; ng, non-game fishery. The first number (2) identifies the stream section. The second number (3) identifies one of the six stream classes defined by Utah Division of Wildlife Resources for Utah's State Water Plan. The last letters (yl) identify a need for a yearlong protection of this water.

[1] Lakes: Notations are the same as stream sections except the numeral that identified stream section has been replaced with the name of the body of water.

Game fish species that inhabit the stream sections or lakes are identified on the map overlays.

[2] The dates given for various use areas or activities of terrestrial wildlife identify when a species is normally present or participating in an activity and also denotes the period when protection from disturbance is needed.

Figures 1. Continued

| Wildlife Use Areas | Use Area Ranking | | |
|---|---|---|---|
| | Substantial-Value | High-Priority[2] | Crucial-Critical[2] |
| Bighorn Sheep<br>Desert (dbs)<br>Rocky Mountain(mbs) | Herd Distribution<br>s-dbs-yl<br>s-dbs-yl | Tallus Slopes<br>(ewes and lambs)<br>h-dbs-yl<br>1-1 to 12-31<br><br>Mesa Tops--<br>1 mile radius<br>(rams)<br>h-dbs-yl<br>1-1 to 10-31 | Rutting Season<br>(tallus slopes)<br>c-dbs-rt<br>11-1 to 12-31<br><br>Lambing Season<br>(tallus slopes)<br>c-dbs-la<br>5-1 to 6-15 |
| Black Bear | Population Distribution<br>s-bb-yl Entire Area | | |
| Cougar | Population Distribution<br>s-c-yl Entire Area | | |
| Elk | Herd Distribution<br>s-c-yl | Winter Range<br>h-e-wt<br>11-1 to 5-15<br><br>Summer Range<br>h-e-su<br>5-16 to 10-31 | Winter Range<br>c-e-wt<br>11-1 to 5-15 |
| Mountain Goat | Herd Distribution<br>s-mg-yl | | |
| Moose | Herd Distribution<br>s-m-yl | | Yearlong<br>c-m-yl<br>1-1 to 12-31 |
| Mule Deer | Herd Unit<br>s-d-yl<br>Herd Unit 35 | Winter Range<br>h-d-wt<br>11-1 to 5-15<br><br>Summer Range<br>h-d-su<br>5-16 to 10-31 | Winter Range<br>c-d-wt<br>11-1 to 5-15<br><br>Summer Range<br>c-d-su<br>5-16 to 10-31 |
| Pronghorn Antelope | Herd Distribution<br>s-pa-yl | Yearlong Range<br>h-pa-yl<br>1-1 to 12-31 | Winter Season<br>c-pa-wt<br>severe snow condition<br><br>Fawning Season<br>c-pa-fa<br>5-12 to 6-20 |

Figure 1. Key for mapable, high-value habitat use areas for wildlife.

| Wildlife Use Areas | Use Area Ranking | | |
|---|---|---|---|
| | Substantial-Value | High-Priority[2] | Crucial-Critical[2] |
| **Terrestrial Use Areas** | | | |
| Abert Squirrel | Population Distribution<br>s-as-yl | | Nest Trees<br>c-as-wt<br>1-1 to 12-31 |
| Band-tailed Pigeon | Summer Distribution<br>s-btp-su ENTIRE AREA | Intensive Use Area<br>h-btp-su<br>4-15 to 10-15 | Breeding Season<br>c-btp-bs<br>5-15 to 8-15 |
| Blue Grouse | Population Distribution<br>s-bg-yl | Brooding Area<br>h-bg-b<br>6-1 to 8-15 | Breeding Territory and Nesting (Mountain brush zone)<br>c-bg-btn<br>3-15 to 6-15 |
| | | | Winter Range (mature, high elevation stands of Douglas fir)<br>c-bg-wt<br>12-1 to 2-28 |
| California Quail | Population Distribution<br>s-cq-yl | | Croplands and Riparian Zones<br>c-cq-yl<br>1-1 to 12-31<br>Nesting Season<br>c-cq-n<br>4-15 to 5-30 |
| Chukar | Population Distribution<br>s-ck-yl | | Winter Range<br>c-ck-wt<br>12-1 to 2-15<br>Nesting Season<br>c-ck-n<br>4-1 to 5-30 |
| Cottontail Rabbit<br>Mountain cottontail found above 7,000 feet elevation.<br>Desert cottontail found below 7,000 feet elevation. | Population Distribution<br>s-mc-yl<br>s-dc-yl | | Nesting Season<br>c-mc or dc-n<br>4-1 to 7-31 |

Figure 1. Continued

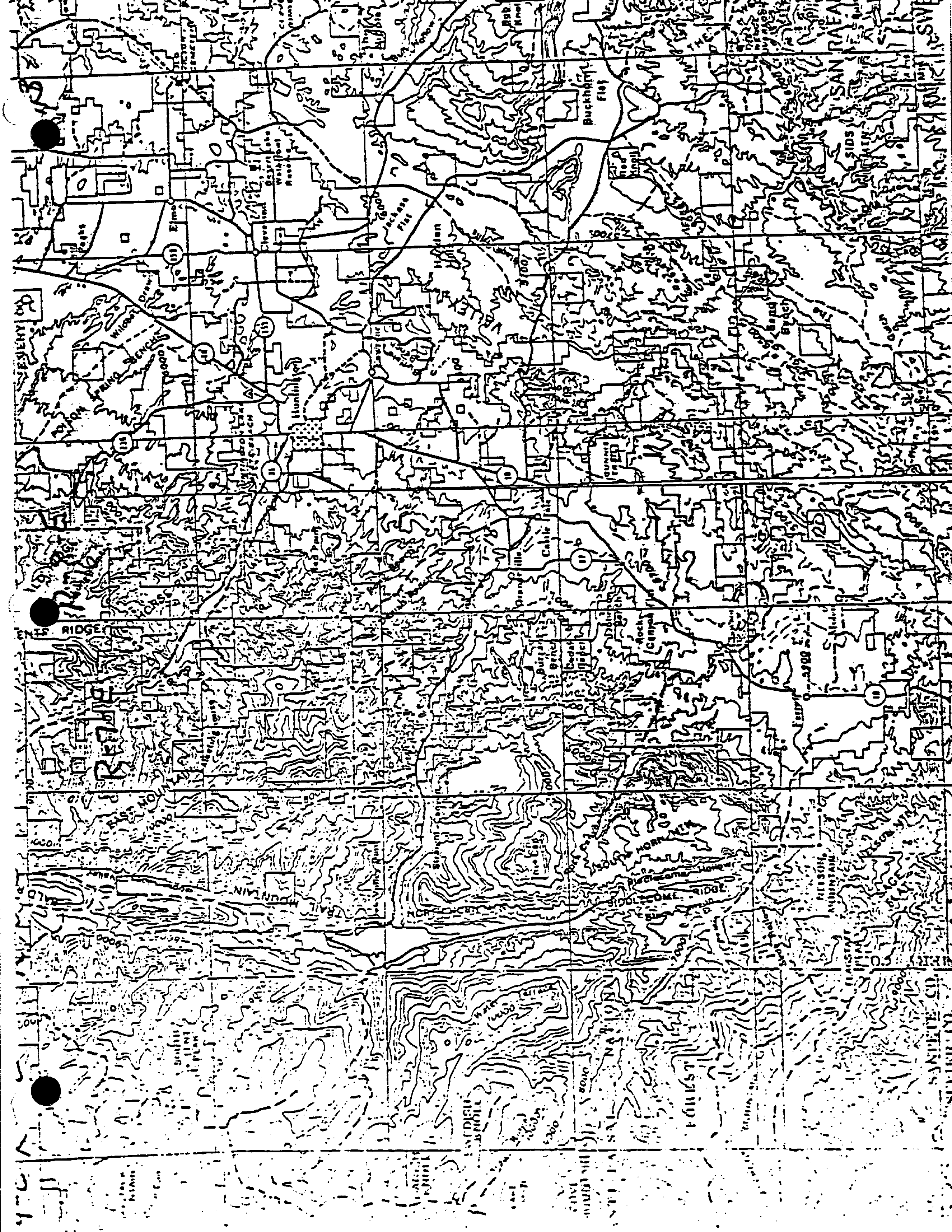
| Wildlife Use Areas | Use Area Ranking | | |
|---|---|---|---|
| | Substantial Value | High-Priority[2] | Crucial-Critical[2] |
| | Terrestrial Use Areas | | |
| Gambel Quail | Population Distribution<br>s-gq-yl | | Riparian Zones<br>c-gq-yl<br>1-1 to 12-31<br>Nesting Season<br>c-gq-n<br>4-15 to 5-30 |
| Merriams Turkey | Population Distribution<br>s-mt-yl | Winter Range<br>h-mt-wt<br>12-1 to 3-31<br>Summer Range<br>h-mt-su<br>6-1 to 11-30 | Display and Nesting Area<br>c-mt-n<br>4-1 to 5-30<br><br>Roost Trees<br>(0.5 mile radius buffer zone)<br>c-mt-rt<br>1-1 to 12-31 |
| Mourning Dove | Population Distribution<br>s-du-su Entire Area | | Nesting Season<br>c-du-n<br>5-1 to 8-31 |
| Pheasant<br>Ring-necked<br>White-winted | Population Distribution<br>s-rnp-yl<br>s-wp-yl | | Croplands and Adjacent Riparian and Wetlands<br>c-rnp or wp-yl<br>1-1 to 12-31<br><br>Nesting Season<br>c-rnp or wp-n<br>5-15 to 7-15 |
| Ruffed Grouse | Population Distribution<br>s-rg-yl | Summer Range<br>(0.25 miles each side of stream courses)<br>h-rg-su<br>3-11 to 11-30 | Brooding Areas<br>(0.25 miles each side of stream courses)<br>c-rg-b<br>6-1 to 8-15<br><br>Winter Range<br>(clone of mature male Aspen near stream)<br>c-rg-wt<br>12-1 to 2-28<br><br>Drumming Log<br>c-rg-dr |

Figure 1. Continued

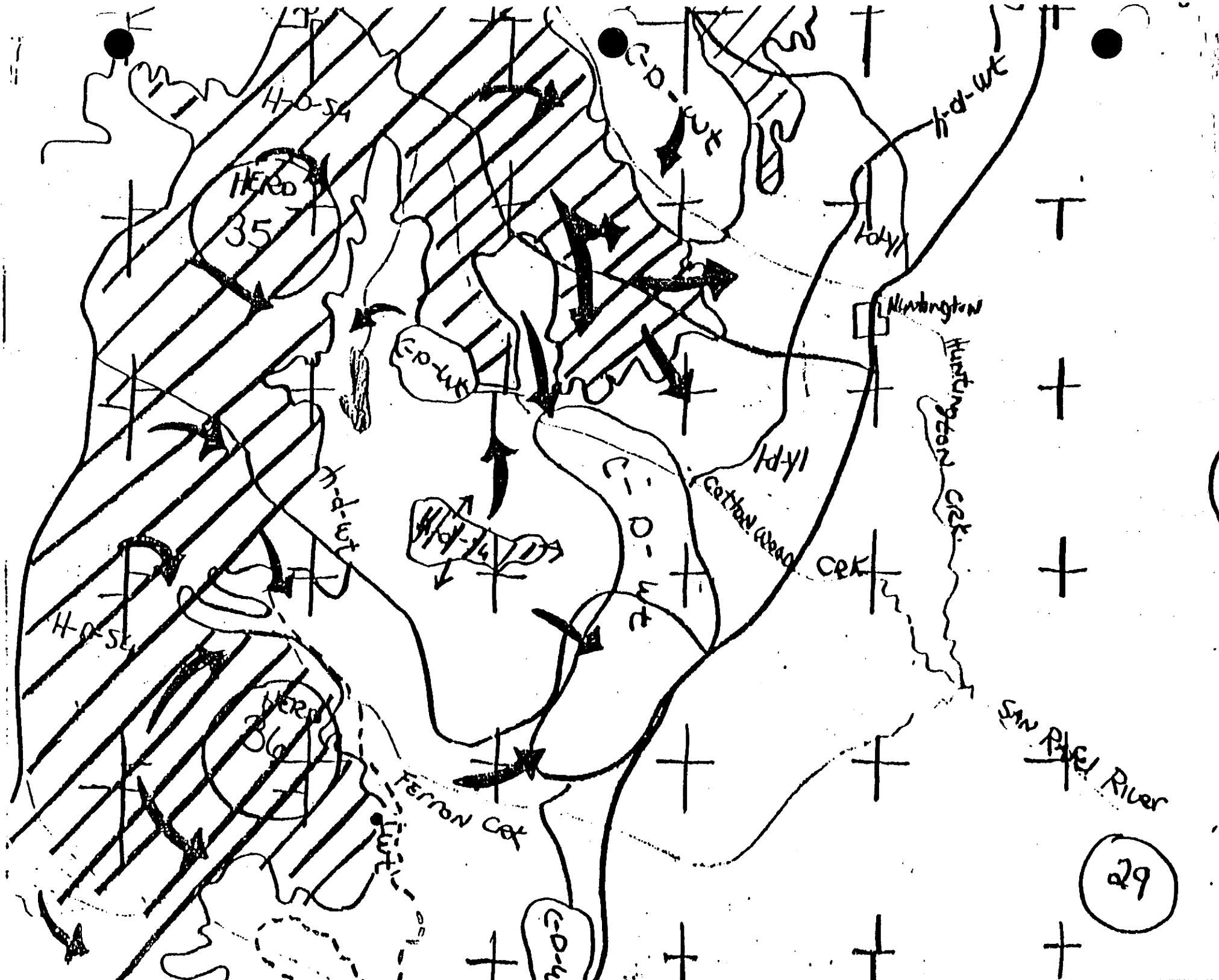
| Wildlife Use Areas | Use Area Ranking | | |
|---|---|---|---|
| | Substantial Value | High-Priority[2] | Crucial-Critical[2] |
| | | Terrestrial Use Areas | |
| Sage Grouse | Population Distribution<br>s-sa-yl | Summer Range<br>s-sa-su<br>8-16 to 11-14 | Strutting Grounds and associated brooding area<br>c-sa-st,b<br>3-15 to 8-15<br><br>Winter Range<br>c-sa-w<br>11-[illegible] to 3-14 |
| Snowshoe Hare | Population Distribution<br>s-sh-yl | | Nesting Season (spruce-fir and lodgepole pine forests)<br>c-sh-n<br>4-1 to 8-15 |
| Waterfowl | Population Distribution (all wetlands, stream courses, ponds and lakes)<br>s-wa-yl | Peak Migration (all wetlands, stream courses, ponds and lakes)<br>h-wa-m<br>3-15 to 5-15 (spring)<br>8-15 to 10-15 (fall)<br><br>Brooding and Mounting Season (all wetlands, stream courses, ponds and lakes)<br>h-wa-bm<br>7-16 to 8-15 | Nesting Season<br>c-wa-n<br>3-15 to 7-15 |

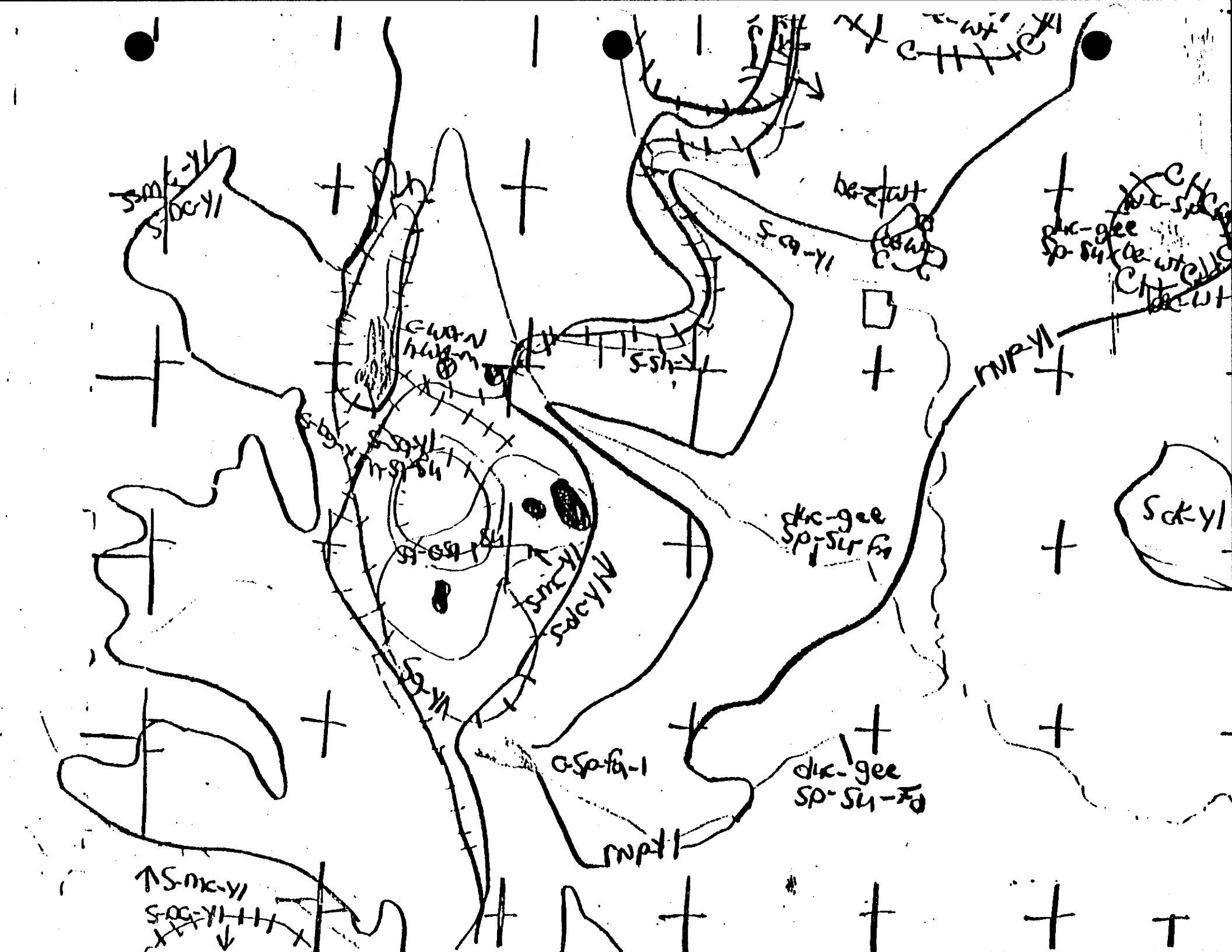
Figure 1. Key for mapable, high-value habitat use areas for wildlife.

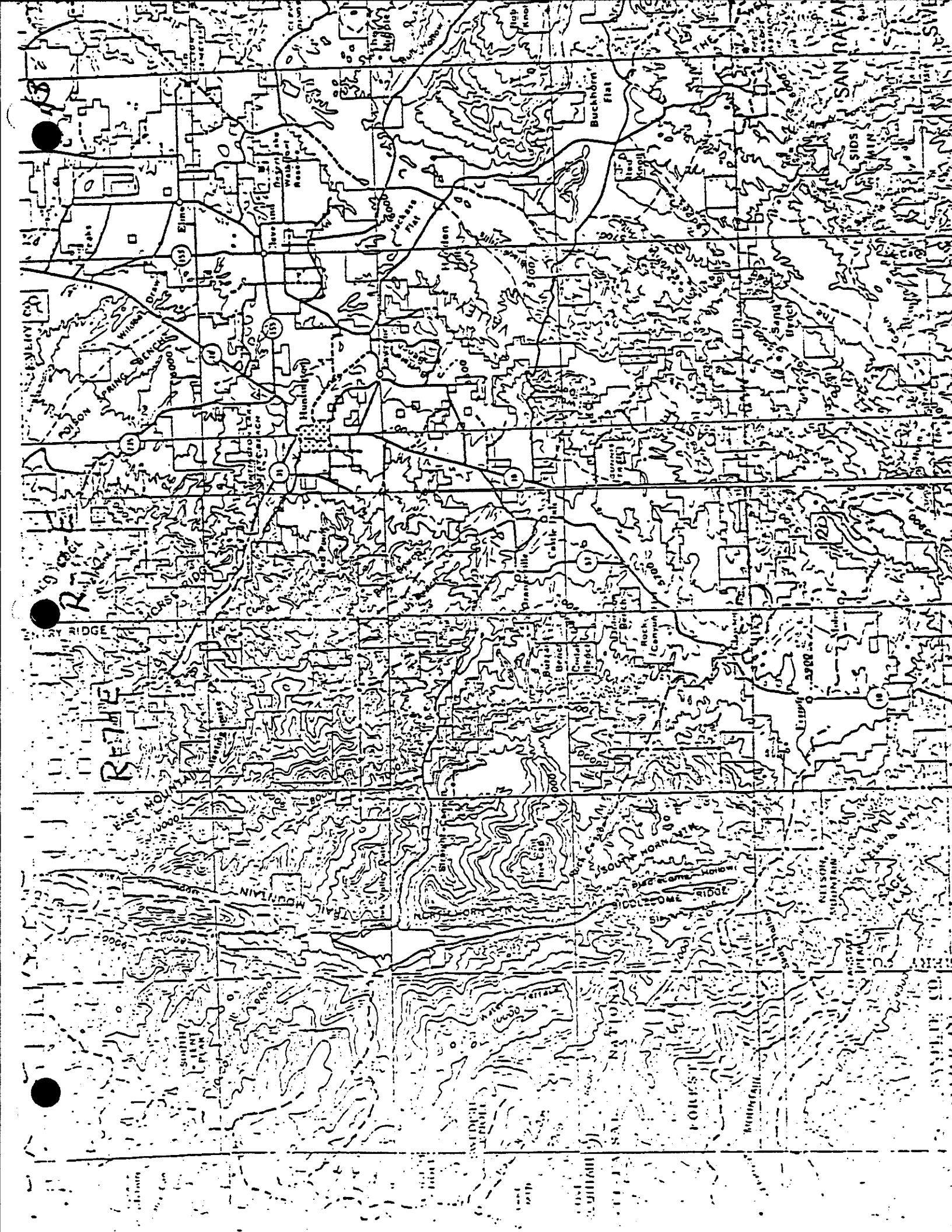
| Wildlife Use Areas | Use Area Ranking | | |
|---|---|---|---|
| | Substantial-Value | High-Priority[2] | Crucial-Critical[2] |
| **Terrestrial Use Areas** | | | |
| Vultures, Accipiters, Buteos (Hawks only), Herriers, Osprey, Merlin, American Kestrel and Owls | Population Distribution (The entire area provides habitat ~~use areas for~~ several species.) | Breeding Territory Surrounds an aerie site | Aerie Site Species specific symbols identified on map-protection needed in 0.25 mile radius buffer zone when in use. |
| Golden Eagle (common year-around resident) | Population Distribution (The entire area provides habitat use areas for this species.) | | Aerie Site ⊗ 2-15 to 6-15 |
| Bald Eagles | Winter Distribution (Entire area between 11-15 and 3-15 each year) | Winter Concentration h-be-wt 11-15 to 3-15 | Roost Tree 11-15 to 3-15 |
| Cliff Nesting Falcon | | | Aerie Site ⊗ 3-1 to 6-30 |



Buckhorn Flat
Jackass Flat
Elmo
Cleveland
Huntington
Castle Dale
Orangeville
Ferron
SPRING BENCH
RIDGE
EAST MOUNTAIN
TRAIL MOUNTAIN
SAN RAFAEL


H-O-St
HFRD
35
C-D-Ext
h-d-wt
Idyll
Huntington
Huntington Crk.
C-D-Ext
Idyll
Cotton Wood
Crk
h-d-Ext
H-d-St
C-D-Ext
H-O-St
HFRD
36
Ferron Crk
Ext
San Rafael River
C-D-Ext
29




Buckhorn Flat
Jackass Flat
Elmo
Willow Springs
Dutch Flat
Red Mountain
Cable Flat
Rock Canyon
Bull Creek
Bull Creek Flat
Rock Corral
Bull Creek Canyon
Bull Creek Ridge
Sourhorn Ridge
Sourhorn Hollow
Ridgecrest Ridge
Ridgecrest Hollow
Ridgecrest
Trail Mountain
East Mountain
Mountain
Ridge
Valley
Canyon
Flat
Hollow
Creek
Spring
Springs
Benches
Divide
Pass
Plain
Plains
Basin
Hills
Butte
Buttes
Peak
Peaks
Summit
Tank
Tanks
Well
Wells
Trail
Road
Roads
Highway
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Boundary
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Townships
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Sections
Meridian
Base Line
Land Grant
Land Grants
Survey
Surveys
Monument
Monuments
Corner
Corners
Line
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Point
Points
Area
Areas
Region
Regions
Zone
Zones
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Tracts
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Charts
Diagram
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Glossary
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Introduction
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Conclusion
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Summary
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List of Figures
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List of Plates
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List of Symbols
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List of Contributors
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Acknowledgments
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Dedication
Foreword
Foreword
Epilogue
Epilogue
Afterword
Afterword
Postscript
Postscript
Addendum
Addendum
Errata
Errata
Corrigenda
Corrigenda
Supplement
Supplement
Appendix
Appendix
Bibliography
Bibliography
Glossary
Glossary
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Index
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Table of Contents
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List of Charts
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List of Diagrams
List of Plates
List of Plates
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List of Illustrations
List of Abbreviations
List of Abbreviations
List of Symbols
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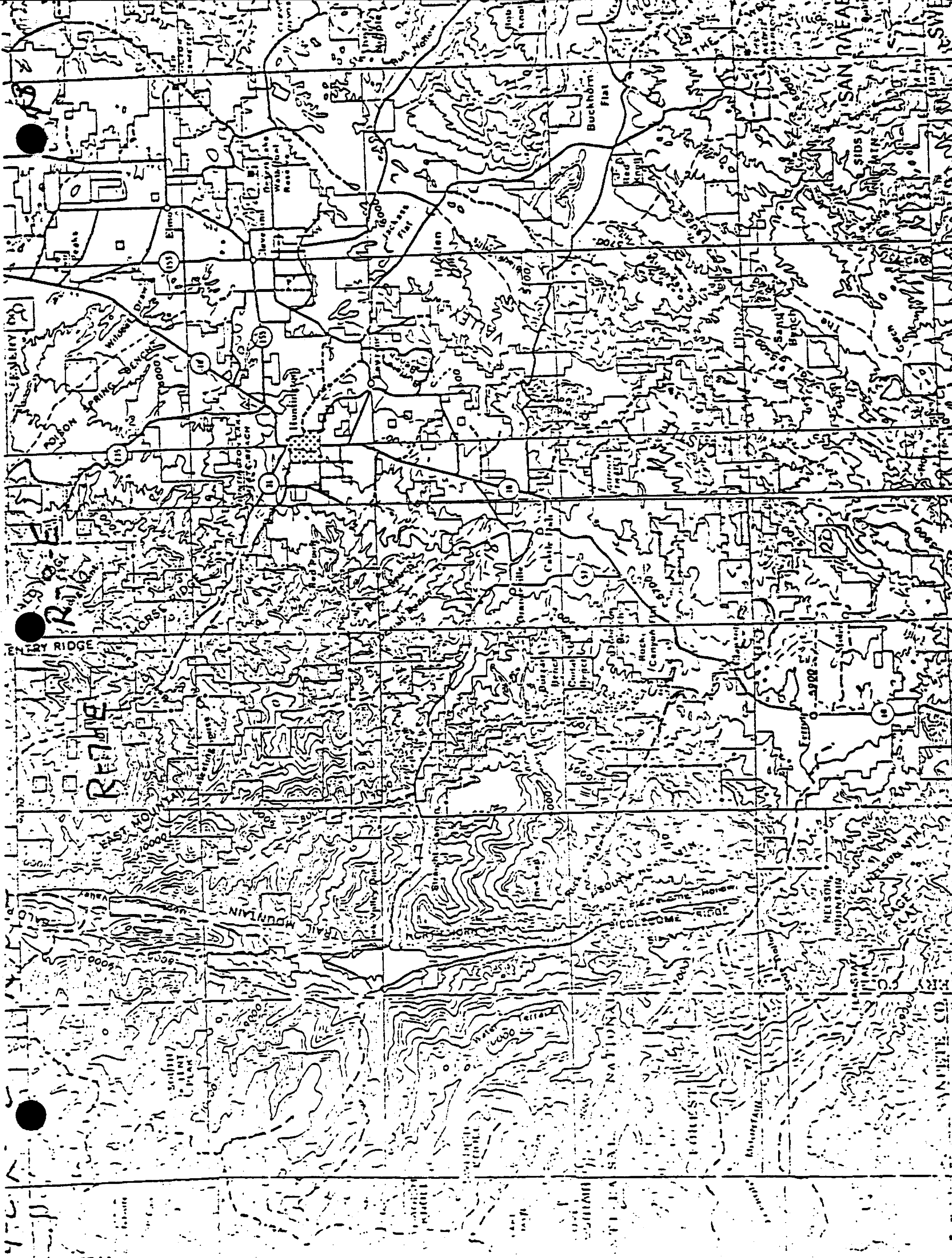
List of Contributors
List of Contributors
Acknowledgments
Acknowledgments
Dedication
Dedication
Foreword
Foreword
Epilogue
Epilogue
Afterword
Afterword
Postscript
Postscript
Addendum
Addendum
Errata
Errata
Corrigenda
Corrigenda
Supplement
Supplement

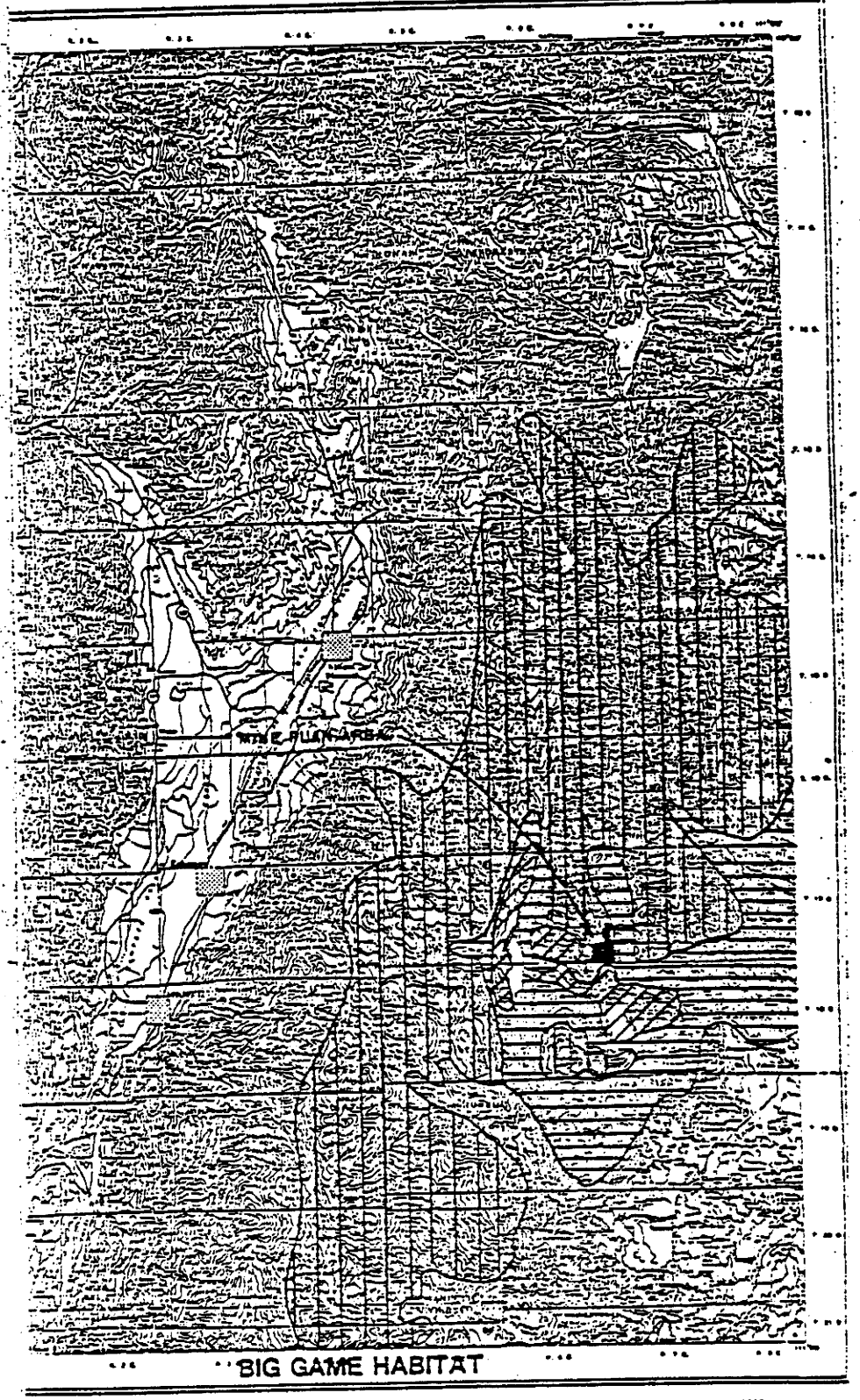
Huntington



Buckhorn Flat
SAN RAFAEL
Red Knoll
Elmo
Cleveland
Jackass Flat
VALLEY
Sand Bench
Huntington
WILSON SPRING BENCH
Castle Dale
Orangeville
Rock Canyon
ENTRY RIDGE
HORSE RIDGE
Ferron
EAST MOUNTAIN
TRAIL MOUNTAIN
NELSON MTN
NATIONAL
FOREST

STATE OF UTAH

LAND OWNERSHIP AND PUBLIC MANAGEMENT



BIG GAME HABITAT

LEGEND

PUBLIC LAND
PRIVATE LAND
STATE LAND
NATIONAL FOREST
CRUCIAL MULE DEER RANGE
HIGH PRIORITY MULE DEER RANGE

June 1988

APPENDIX 3-10-3

ABUNDANCY OF MULE DEER WITH THE PERMIT AREA

# APPENDIX 10-3

## ABUNDANCY OF MULE DEER WITHIN THE PERMIT AREA

## Abundancey of Mule Deer within the permit area and access road.

(Larry Dalton, Division of Wildlife Resourses, Price, Utah)
Animal population is much to dynamic to attach a meaninful number figure. It is possible for an entire mule deer herd to be in the related mine plan and access areas of Trail Mountain No.9 Mine one day and it is possible that they may never be in that area again. Also, the fluxation in population of deer herds from day to day and season to season makes it impossible to attach meaningful number values.

The Division of Wildlife Resources incorporates a ranking system. (see Appendix 10-2)

# APPENDIX 3-10-6

# RAPTOR PROTECTION

# APPENDIX 10-6

# RAPTOR PROTECTION

...AH
... RESOURCES & ENERGY
...ing
... Lake City ... 841...

... Director
... Executive Director
... Division Director

November 26, 1982

Mr. Andy King
Natomas Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537

RE: Raptor Protection on Powerlines
Trail Mountain Mine
ACT/015/009
Emery County, Utah

Dear Mr. King:

The U S Fish and Wildlife Service (USFWS) has completed a survey of existing powerlines as per your request of May 26, 1982. The USFWS has found the design and construction of the existing powerlines at the Trail Mountain Mine to be "safe" to raptors (survey results enclosed). Therefore modification of the existing powerpoles will not be required.

Should you have any questions or concerns, please don't hesitate to call.

Sincerely,

LYNN KUNZLER
RECLAMATION BIOLOGIST

LK/lm

cc: OSM, Albuquerque
Ken Wyatt, DOGM

Enclosure

Board: Charles R Henderson, Chairman ... Edward T Beck
Robert R Norman ... Margaret ...

... equal opportunity employer ...

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

APPENDIX 3-10-7

MACROINVERTEBRATE STUDY

Beaver Creek Coal Company
Trail Mountain No.9 Mine

# APPENDIX 10-7

# MACROINVERTEBRATE STUDY

2/1/88

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

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| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
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When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

Interim Report

# The Benthic Macroinvertebrates of Cottonwood Creek

Prepared for the
Trail Mountain Coal Company

by
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## Station Description

The benthic community of Cottonwood Creek was examined at two locations, Surface Water Monitoring Stations SW-1 and SW-2. These stations were sampled on July 31, 1985 and again on October 25, 1985. Station SW-1 is located upstream from the Trail Mountain Coal Company facilities. The riparian vegetation produces a closed canopy over the stream. The stream bed itself is a large rubble substrate with a matrix of sand. Station SW-2 is downstream from the mining facilities and the riparian vegetation is more open resulting in very little shading of the station. The substrate here is a small rubble with a matrix of sand. The matrix and rubble tended to be cemented together by a calcarious marl. The marl was more noticeable on the first sampling date.

## Sampling Procedure

Four samples were taken at each station. This number of samples was determined to be adequate for monitoring purposes. Samples were taken with a standard surber sampler with a 351 micron mesh net. Sampler positioning within each sampling station was determined randomly so as to eliminate any potential investigator induced bias. The substrate was removed to a depth of ten centimeters and placed in a plastic container. The contents of the surber sampler was also washed into this container. The sample was preserved with a 10% formalin solution with rose bengal stain added. The samples were washed in the laboratory and organic materials were retained in a 64 micron mesh sieve. The organic residue was washed into a bottle and preserved with the 10 % formalin - rose bengal solution until it could be sorted. The sediments were oven dried and then separated into size fractions with a Tyler sieve shaker set at 20 minutes. The size fractions were weighed to determine proportional weight content.

Sample sorting was done under a dissecting microscope. Organisms were removed and placed into two dram vials and 70% ethyl alcohol was added as a preservative. These samples were later sorted to Order and Family levels and Generic identification was accomplished with the use of several keys for aquatic invertebrates (see bibliography). Identification was made with a dissecting microscope and occasionally with the aid of a compound microscope for those specimens which required dissection and slide mounting.

## Preliminary Results

The sediment data are summarized in a table. While this only depicts the average proportional composition for each sampling site and sampling date, it does reveal the gross differences between the sediments of the two stations. SW-1 on both sampling dates had the highest proportion of the substrate particles in the 64mm + category (74% and 64% respectively). While SW-2 samples taken on 10-25-85 did have the dominant substrate as 64mm + (53%), it is also apparent that the smaller rubble sizes are more predominant. For instance the 32-8 mm size range for SW-1 was 11% and 14% for July and October respectively while the same size range for SW-2 was 40% and 25%. This implies that substrate may be important in influencing the structure of the communities at the two respective stations and a certain degree of confounding may occur when attempting to determine any impact form mining activities. An additional confounding factor was alluded to earlier, that is the difference in canopy cover at the two sites. The open canopy of station SW-2 is likely the cause of the calcareous marl on the substrate. The marl is induced by the action of photosynthetic organisms, in this case epilithic algae. This marl will reduce the interstitial spaces available to the benthic fauna and thus will

influence the community. The reduced marl on the second sampling date could be from either lower overall photosynthesis on the benthos due to season or it could result from the disturbance induced by the sampling three months earlier in July. Regardless, the samples taken in October are more comparable between stations than are those taken in July. This is easily seen in the densities of the invertebrates. The October samples are more similar between the stations than are the July samples. In July the SW-2 station has about 30% fewer taxa than SW-1, while in October SW-2 has approximately the same number of taxa. From these preliminary results it appears that the mining activities are having little or no impact on the stream communities, although more definitive conclusions must await a final analysis with quantitative methods.

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## Substrate Size (%)

| Date and Sample | Rubble (mm) 64+ | 64-32 | 32-8 | Gravel (mm) 8-4 | 4-2 | 2-1 | Sand (mm) 1-.5 | .5-.25 | .25-.125 | .125-.063 |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/31/85 SW-1 | 74.2 | 9.6 | 10.7 | 2.1 | 1.3 | 0.6 | 0.4 | 0.9 | 0.2 | 0.2 |
| 7/31/85 SW-2 | 12.6 | 26.3 | 39.8 | 7.8 | 4.0 | 2.5 | 2.3 | 4.4 | 0.5 | 0.1 |
| 10/25/85 SW-1 | 64.4 | 13.1 | 13.9 | 4.2 | 1.3 | 0.7 | 0.6 | 1.5 | 0.5 | 0.1 |
| 10/25/85 SW-2 | 52.8 | 14.2 | 25.0 | 4.2 | 1.2 | 0.6 | 0.4 | 1.0 | 0.5 | 0.1 |

Date: 7-31-85
Sample site: SW-1

| | Sample Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ephemeroptera | | | | |
| Baetidae | | | | |
| *Baetis* sp. | 285 | 72 | 147 | 148 |
| Heptageniidae | | | | |
| *Heptagenia* sp. | 0 | 0 | 0 | 0 |
| Plecoptera | | | | |
| Perlodidae | | | | |
| *Cultus* sp. | 29 | 19 | 8 | 13 |
| Chloroperlidae | | | | |
| *Chloroperla* sp. | 3 | 0 | 0 | 0 |
| Nemouridae | | | | |
| *Malenka* sp. | 0 | 5 | 3 | 11 |
| Trichoptera | | | | |
| Hydropsychidae | | | | |
| *Hydropsyche* sp. | 11 | 3 | 3 | 5 |
| Brachycentridae | | | | |
| *Brachycentrus* sp. | 0 | 0 | 0 | 3 |
| Limnephilidae | 0 | 0 | 0 | 0 |
| Diptera | | | | |
| Chironomidae | 24 | 3 | 21 | 5 |
| Rhagionidae | | | | |
| *Atherix variegata* | 0 | 3 | 0 | 0 |
| Simuliidae | | | | |
| *Prosimulium* sp. | 77 | 0 | 19 | 5 |
| Tipulidae | | | | |
| *Tipula* sp. | 0 | 0 | 0 | 0 |
| Coleoptera | | | | |
| Dytiscidae | | | | |
| nr. *Agabus* | 0 | 0 | 0 | 3 |
| Copepoda | 0 | 0 | 0 | 0 |
| Harpacticoida | 19 | 64 | 8 | 11 |
| Oligocheta | 0 | 0 | 0 | |
| Nematoda 0 | | | | |

Date: 7-31-85
Sample site: SW-2

| | Sample Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ephemeroptera | | | | |
| Baetidae | | | | |
| *Baetis sp.* | 259 | 149 | 155 | 75 |
| Heptageniidae | | | | |
| *Heptagenia sp.* | 0 | 0 | 0 | 0 |
| Plecoptera | | | | |
| Perlodidae | | | | |
| *Cultus sp.* | 0 | 3 | 3 | 11 |
| Chloroperlidae | | | | |
| *Chloroperla sp.* | 0 | 0 | 0 | 0 |
| Nemouridae | | | | |
| *Malenka sp.* | 0 | 3 | 8 | 3 |
| Trichoptera | | | | |
| Hydropsychidae | | | | |
| *Hydropsyche sp.* | 3 | 0 | 0 | 8 |
| Brachycentridae | | | | |
| *Brachycentrus pp.* | 0 | 0 | 0 | 0 |
| Limnephilidae | 0 | 0 | 0 | 0 |
| Diptera | | | | |
| Chironomidae | 5 | 8 | 19 | 16 |
| Rhagionidae | | | | |
| *Atherix variegata* | 0 | 0 | 0 | 0 |
| Simuliidae | | | | |
| *Prosimulium sp.* | 3 | 8 | 13 | 0 |
| Tipulidae | | | | |
| *Tipula sp.* | 0 | 0 | 0 | 0 |
| Coleoptera | | | | |
| Dytiscidae | | | | |
| nr. *Agabus* | 0 | 0 | 0 | 0 |
| Copepoda | | | | |
| Harpacticoida | 0 | 3 | 0 | 0 |
| Oligocheta | 32 | 45 | 13 | 21 |
| Nematoda 11 | 3 | 0 | 0 | |

Date: 10-25-85
Sample site: SW-1

| | Sample Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ephemeroptera | | | | |
| Baetidae | | | | |
| *Baetis* sp. | 139 | 115 | 45 | 139 |
| Heptageniidae | | | | |
| *Heptagenia* sp. | 5 | 5 | 0 | 3 |
| Plecoptera | | | | |
| Perlodidae | | | | |
| *Cultus* sp. | 5 | 11 | 0 | 8 |
| Chloroperlidae | | | | |
| *Chloroperla* sp. | 19 | 13 | 0 | 0 |
| Nemouridae | | | | |
| *Malenka* sp. | 8 | 0 | 0 | 0 |
| Trichoptera | | | | |
| Hydropsychidae | | | | |
| *Hydropsyche* sp. | 13 | 5 | 3 | 11 |
| Brachycentridae | | | | |
| *Brachycentrus* sp. | 0 | 0 | 0 | 0 |
| Limnephilidae | 0 | 0 | 0 | 0 |
| Diptera | | | | |
| Chironomidae | 5 | 12 | 11 | 24 |
| Rhagionidae | | | | |
| *Atherix variegata* | 0 | 8 | 0 | 0 |
| Simuliidae | | | | |
| *Prosimulium* sp. | 0 | 0 | 0 | 5 |
| Tipulidae | | | | |
| *Tipula* sp. | 0 | 0 | 0 | 0 |
| Coleoptera | | | | |
| Dytiscidae | | | | |
| nr. *Agabus* | 0 | 0 | 0 | 0 |
| Copepoda | | | | |
| Harpacticoida | 0 | 0 | 0 | 0 |
| Oligocheta | 19 | 29 | 53 | 35 |
| Nematoda 0 | 0 | 3 | 0 | |

Date: 10-25-85
Sample site: SW-2

| | Sample Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ephemeroptera | | | | |
| Baetidae | | | | |
| *Baetis* sp. | 557 | 275 | 93 | 115 |
| Heptageniidae | | | | |
| *Heptagenia* sp. | 0 | 8 | 3 | 0 |
| Plecoptera | | | | |
| Perlodidae | | | | |
| *Cultus* sp. | 27 | 16 | 5 | 0 |
| Chloroperlidae | | | | |
| *Chloroperla* sp. | 12 | 0 | 3 | 0 |
| Nemouridae | | | | |
| *Malenka* sp. | 0 | 0 | 0 | 0 |
| Trichoptera | | | | |
| Hydropsychidae | | | | |
| *Hydropsyche* sp. | 3 | 3 | 5 | 0 |
| Brachycentridae | | | | |
| *Brachycentrus* sp. | 0 | 0 | 0 | 0 |
| Limnephilidae | 3 | 0 | 0 | 3 |
| Diptera | | | | |
| Chironomidae | 5 | 275 | 83 | 261 |
| Rhagionidae | | | | |
| *Atherix variegata* | 3 | 0 | 3 | 0 |
| Simuliidae | | | | |
| *Prosimulium* sp. | 0 | 0 | 0 | 0 |
| Tipulidae | | | | |
| *Tipula* sp. | 5 | 0 | 0 | 0 |
| Coleoptera | | | | |
| Dytiscidae | | | | |
| nr. *Agabus* | 0 | 0 | 3 | 0 |
| Copepoda | | | | |
| Harpacticoida | 0 | 0 | 0 | 0 |
| Oligocheta | 77 | 45 | 3 | 64 |
| Nematoda 8 | 0 | 0 | 0 | |

# BENTHIC MACROINVERTIBRATES

## FINAL REPORT (1986)

# Final Report

# Cottonwood Creek Macroinvertebrate Assessment

# for the

# Trail Mountain Coal Company

by

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## Introduction and Purpose

The Utah Division of Oil, Gas and Mining and the United States Department of the Interior have required a study of the Cottonwood Creek macroinvertebrate community with the objective of documenting any negative impacts of the Trail Mountain Coal Company mining operations on the stream system. The instructions were to compare the faunal elements over three sampling periods at two stations on Cottonwood Creek. A total of four samples per station were recommended. This report details the results of the study and interprets the similarities and dissimilarities of the two communities and the habitat found at each station.

## Description of Study Area

The study was conducted from two preestablished sampling stations in Cottonwood Canyon, Emery County, Utah. These sites are the surface water monitoring stations SW-1 and SW-2 of the Hydrologic Monitoring program established by the Trail Mountain Coal Company in compliance with requirements by the Utah Division of Oil, Gas & Mining and the United States Department of the Interior. SW-1 is above the Trail Mountain Coal Company mining facilities and represents a control, or non impact section. SW-2 is approximately one kilometer downstream from the facilities and represents the portion of the stream where mining impacts would be expected if such impacts occur.

The upstream station, SW-1 is located in a shaded portion of the stream, with a relatively dense overhead canopy of Cottonwood (Populus sp.) and a riparian of varied native shrubs. The stream passes through a narrow channel, confined by steep side walls. The substrate is large rubble with a sand matrix. SW-2 is in a more open setting, and has significantly less overstory cover. The stream bed is, for the most part, exposed to direct sunlight. The bank slopes gradually to the stream bed from the east, while the western bank is steep, similar to the banks at location SW-1. The substrate here is a small rubble with a matrix of sand. The matrix and rubble tended to be cemented together with a calcarious marl, and this marl was best developed during the summer sampling period.

## Materials and Methods

### Sampling Methods

Samples were taken three times during the year: July 31, 1985; October 25, 1985 and February 9, 1986. Four replicate samples were taken per station using a one square foot surber sampler with a net mesh of 351 microns. The positioning of each sample was determined with random numbers to avoid any bias by the investigator. Once the sample position was determined, the surber sampler was centered directly over the sampling point. Large rocks found within the sample area were washed and measured in the field, but were not retained for laboratory processing. The volume of each rock was used to determine its approximate weight for sediment analysis. The remaining substrate in each sample was removed to a depth of 4 inches (10 cm.) and placed in a polyethylene jar. Excess water was removed by filtering through a 64 micron mesh sieve. The contents of the surber sampler net was also washed into the sieve and then transferred into the jar. Samples

were preserved with ten percent formalin. Rose bengal stain was added to aid in laboratory processing.

Samples were transported to the laboratory where the sediments were separated from the benthic invertebrates using elutriation (Shiozawa 1986). The elutriated organic residue was collected with a 65 micron mesh sieve, washed into a jar, and preserved with a 10% formalin - rose bengal solution. The inorganic residual was retained for sediment analysis. The samples were picked under a stereo dissecting scope and the recovered invertebrates were sorted and separated by genus or species when possible. The sediments were oven dried at 120 degrees centigrade to a constant weight. The dried material was then placed in a series of nested sieves sized according to the phi scale (Cummins, 1962; Cummins and Lauff, 1969), beginning at 250 microns mesh diameter. The sieves were then placed on a Tyler sediment shaker for 20 minutes. The size fractions were weighed and the resulting percents were used to characterize the sediments distribution in each sample.

Samples were sorted with a dissecting microscope using fiber optics lighting. Organisms were enumerated and placed into vials. The sorted invertebrates were preserved with 70% ethyl alcohol. The preserved samples were later sorted to Order and Family and the Genus and Species were determined when possible using standard keys for aquatic invertebrates (Baumann, Gaufin and Surdick, 1977; Edmondson, 1959; Edmunds, Jensen and Berner, 1976; Hitchcock, 1974; Merritt and Cummins,1978; Ross, 1944; Usinger, 1971; Wiggens, 1977). Identifications were made under a dissecting microscope and occasionally with slide mounted specimens viewed with a compound microscope.

## Results and Discussion

Analysis of aquatic impact data has traditionally focused on either the invertebrate community or the water chemistry of the stream areas in question. Water chemistry (which has been monitored separately and is not of consideration in this report) has the advantage of giving direct levels of potential contaminants reaching a given site and, in that sense, simplifies management decisions when pre-established toxicant levels are exceeded. However water chemistry varies regionally as well as seasonally (Hem 1970), and the conditions present in one system can remove or neutralize materials which might be toxic or stressful under other conditions. In addition a serial water sampling program represents point data and does not detect pollutants which may enter the system for only short periods of time, such as immediately following a storm (storm runoff) or materials that are only periodically discharged into the stream system. Materials which may enter the stream in sublethal quantities can still impact the aquatic community yet not exceed established standards and some materials may be difficult or prohibitively expensive to measure and assess chemically. The use of the biotic community is advantageous under such conditions. Lotic organisms will respond to stress if it exceeds their tolerance limits. Thus a single slug flow of a toxicant may result in the elimination or reduction of certain species and favor the multiplication or survival of other more tolerant species. The resulting shift in community structure can be detected long after the stressing factor(s) have left the system. This initially led investigators to develop the concept of indicator species

(Gaufin and Tarzwell, 1956; Tarzwell and Gaufin, 1953) where certain species were considered to be indicative of stress, especially organic pollution. If these indicators were present, then pollution was likely.

Later with the adaptation of information theory to ecology (Margalef 1957) an additional tool was made available for such evaluation. Information theory predicted that the number of pathways available for information transfer was directly correlated with the stability of information systems. A direct adaptation of this concept to that of trophic associations and food web connectivity led to the widespread use of diversity indices as a measure of the stability of natural and perturbed systems ( Margalef, 1957; MacArthur, 1972; Patrick, 1963; Pielou, 1975). The Shannon-Weiner (Shannon and Weaver 1949) index of diversity became widely used in evaluating impacts in the early 1970's. This index for diversity is:

$$H' = \text{sum}(pi * \log(p_i))$$

where H' = the Shannon Weiner Index of diversity
$p_i$ = the proportion of species i in the sampled community

This function is maximum when $p_i = 1/S$ for all S species in the sample. That is:

$$H'max = S((1/S) * \log(1/S))$$

where H'max = the maximum diversity
S = the total number of species in the sample

Assuming that the ideal community would have maximum diversity, the nearness to this ideal state could be calculated. This measure of nearness to the ideal is called evenness and is found with the formula:

$$E = H'/H'max$$

where E = evenness
H' = the Shannon-Weiner Diversity Index
H' = the maximum diversity index defined above

Evenness ranges between 0 and 1 where 1 is maximum evenness.

As more was understood about natural communities the connection between diversity and stability began to come under question (see Pielou, 1975) and the use of diversity and evenness alone as an index of environmental stress became limited. An association between diversity and stability may exist (May, 1974) but that association is in no way as simplistic as the original users of information theory had assumed. The most reasonable use of diversity indices now are for comparisons of adjacent sites, such as is the case in this study where two stations on the same stream are being compared. Regional and broad geographical comparisons are likely to be less valid, especially when interpretations associated with the condition or quality of various systems are being considered.

In 1972 Chutter recommended the use of a biotic index to assess the impact of perturbations on aquatic systems. This index was designed to allow a

quantitative evaluation of the indicator species concept. All species in the sampled station are enumerated and each is assigned a value according to it's importance as an indicator. The higher the value, the higher the tolerance is to stressful conditions. Species values range from zero to ten and the density of each species is included in the computation of the index. The index is:

$$BI = (Sum(n_i * s_i))/N$$

where BI = the biotic index
$n_i$ = the importance value of the ith species
$s_i$ = the density of species i in the sample being evaluated
N = the total number of organisms in the sample

Here values of unperturbed systems are generally considered to be in the range of 0-2, while values of 2-4 indicate slightly enriched (stressed) situations, 4-7 are typical of enriched waters and 7-10 are characteristic of polluted waters (Hilsenhoff 1977).

Additional factors can be useful when interpreting the relative conditions of several sites. One is the influence of substrate on community structure (DeMarch, 1976) and another is the functional grouping of stream organisms (Cummins 1974). In this report these various techniques were used in extracting information relative to the impact of the Trail Mountain Coal company operations on Cottonwood Creek.

Sediment Characterization

The sediment size frequencies for each sample taken during the study are listed in Tables I, II and III. Sediments have been shown to undergo a seasonal change in structure associated with annual changes in discharge in some stream systems (DeMarch, 1976; Shiozawa, 1986). This has implications for community structure since the substrate essentially establishes the template on which the community is structured (Shiozawa 1983). Differences in sediment dynamics or in sediment structure at the two stations could induce differences in the community structure and thus complicate the interpretation of the data. Station SW-1 shifts from slightly higher percentages in the 64+mm size range to more in the 32-8 mm sizes between July and October of 1985. These particles are in the gravel sizes, and indicate selective erosion of sands from the substrate. Essentially no change in substrate size frequency occurred between October and the February samples at SW-1. Station SW-2 underwent an increase in the coarse material greater than 64 mm in size between July and October. This implies the erosion of sands and gravels from the substrate. Between October and February the proportion of gravels increased in the samples and deposition is the likely source of materials. It appears that the stations are undergoing different sediment dynamics. If annual sediment deposition - erosion cycles occur, then station SW-1 is undergoing a change from a depositional environment in the early-mid summer to an erosional one in the fall. Over the winter it stabilizes and in the spring runoff it should become erosional again. Once water levels stabilize the stream becomes depositional, replacing the materials lost to the spring floods. Station SW-2 underwent an erosional period between July and October with

Table 1. Sediment size frequency data for samples collected on 7-31-85

Station: SW-1

| Sample | Percent Composition | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
| 1 | 82.1 | 8.3 | 7.6 | 0.8 | 0.4 | 0.2 | 0.2 | 0.4 |
| 2 | 62.8 | 16.9 | 12.9 | 3.1 | 1.7 | 0.8 | 0.5 | 1.3 |
| 3 | 75.8 | 13.0 | 7.7 | 1.2 | 0.7 | 0.3 | 0.2 | 1.1 |
| 4 | 75.9 | 0.0 | 14.4 | 3.5 | 2.2 | 1.1 | 0.8 | 2.1 |
| | --- | --- | --- | --- | --- | --- | --- | --- |
| Mean | 74.15 | 9.55 | 10.65 | 2.15 | 1.25 | 0.60 | 0.43 | 1.23 |
| Std. Deviation | 7.03 | 6.30 | 3.05 | 1.17 | 0.73 | 0.37 | 0.25 | 0.61 |

Mean Sediment Diversity: 0.929741
Mean Sediment Evenness: 0.447111

Station: SW-2

| Sample | Percent Composition | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
| 1 | 34.2 | 33.7 | 19.7 | 7.8 | 1.7 | 0.9 | 0.6 | 1.4 |
| 2 | 16.0 | 28.0 | 17.9 | 9.6 | 6.3 | 4.9 | 5.7 | 11.6 |
| 3 | 0.0 | 0.0 | 75.9 | 8.8 | 5.7 | 3.1 | 2.1 | 4.4 |
| 4 | 0.0 | 43.3 | 45.6 | 4.9 | 2.3 | 1.0 | 0.6 | 2.3 |
| | --- | --- | --- | --- | --- | --- | --- | --- |
| Mean | 12.55 | 26.25 | 39.78 | 7.78 | 4.00 | 2.48 | 2.25 | 4.93 |
| Std. Deviation | 14.10 | 26.25 | 23.56 | 1.79 | 2.02 | 1.65 | 2.05 | 4.00 |

Mean Sediment Diversity: 1.630813
Mean Sediment Evenness: 0.784255

Table II. Sediment size frequency data for samples collected on 10-25-85

Station: SW-1

| Sample | Percent Composition | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
| 1 | 55.3 | 16.9 | 21.9 | 3.0 | 0.8 | 0.4 | 0.3 | 1.4 |
| 2 | 79.9 | 14.7 | 2.6 | 1.1 | 0.6 | 0.3 | 0.2 | 0.6 |
| 3 | 76.9 | 7.1 | 9.7 | 2.3 | 1.3 | 0.7 | 0.5 | 1.5 |
| 4 | 45.3 | 13.8 | 21.5 | 10.5 | 2.4 | 1.3 | 1.2 | 4.0 |
| Mean | 64.35 | 13.13 | 13.93 | 4.23 | 1.28 | 0.68 | 0.55 | 1.88 |
| Std. Deviation | 14.53 | 3.66 | 8.17 | 3.69 | 0.70 | 0.39 | 0.39 | 1.28 |

Mean Sediment Diversity: 1.150947
Mean Sediment Evenness: 0.553958

Station: SW-2

| Sample | Percent Composition | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
| 1 | 0.0 | 35.9 | 43.6 | 13.1 | 3.1 | 1.5 | 0.9 | 1.9 |
| 2 | 71.2 | 14.4 | 10.9 | 1.5 | 0.6 | 0.3 | 0.2 | 0.9 |
| 3 | 55.9 | 7.5 | 32.8 | 1.3 | 0.9 | 0.4 | 0.3 | 0.9 |
| 4 | 84.6 | 0.0 | 12.7 | 0.9 | 0.3 | 0.3 | 0.3 | 0.9 |
| Mean | 52.93 | 14.45 | 25.00 | 4.20 | 1.23 | 0.63 | 0.43 | 1.15 |
| Std. Deviation | 32.20 | 13.39 | 13.76 | 5.14 | 1.10 | 0.51 | 0.28 | 0.43 |

Mean Sediment Diversity: 1.256215
Mean Sediment Evenness: 0.604112

Table III. Sediment size frequency data for samples collected on 2-9-86

Station: SW-1

| Sample | Percent Composition 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
|---|---|---|---|---|---|---|---|---|
| 1 | 46.2 | 12.5 | 21.8 | 7.6 | 3.9 | 2.2 | 1.9 | 3.9 |
| 2 | 85.0 | 3.6 | 6.1 | 1.9 | 1.0 | 0.7 | 0.7 | 1.0 |
| 3 | 72.8 | 11.8 | 10.2 | 2.5 | 0.9 | 0.4 | 0.3 | 1.1 |
| 4 | 58.0 | 22.0 | 16.6 | 1.9 | 0.7 | 0.3 | 0.2 | 0.3 |
| | --- | --- | --- | --- | --- | --- | --- | --- |
| Mean | 65.50 | 12.48 | 13.68 | 3.48 | 1.63 | 0.90 | 0.78 | 1.58 |
| Std. Deviation | 14.68 | 6.52 | 6.00 | 2.39 | 1.32 | 0.76 | 0.68 | 0.38 |

Mean Sediment Diversity: 1.138008
Mean Sediment Evenness: 0.547266

Station: SW-2

| Sample | Percent Composition 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 39.3 | 42.0 | 5.8 | 2.8 | 2.0 | 2.2 | 5.9 |
| 2 | 79.2 | 5.3 | 8.9 | 3.3 | 1.8 | 0.9 | 0.4 | 0.2 |
| 3 | 0.0 | 9.8 | 77.1 | 7.7 | 2.8 | 1.2 | 0.6 | 0.8 |
| 4 | 13.5 | 14.7 | 58.0 | 6.5 | 2.8 | 1.3 | 0.9 | 1.9 |
| | --- | --- | --- | --- | --- | --- | --- | --- |
| Mean | 23.18 | 17.28 | 46.60 | 5.83 | 2.55 | 1.35 | 1.03 | 2.20 |
| Std. Deviation | 32.81 | 13.14 | 25.06 | 1.61 | 0.43 | 0.40 | 0.70 | 2.22 |

Mean Sediment Diversity: 1.446200
Mean Sediment Evenness: 0.695475

even more coarse materials being removed than in station SW-1. From October to February deposition occurred. In the spring the runoff would again be expected to act as an erosional factor. The difference in the size of particles deposited is indicative of the stream velocity in the two sites. Station SW-2 has a higher gradient than does station SW-1 and higher velocity water will carry larger particles. However the sediment determinations were based upon the four replicate random samples. Other studies (DeMarch, 1976; Shiozawa, 1986) relied upon more replicates per station and sampled much more frequently when deriving the seasonal patterns. Thus the three sampling periods used here can give only partial support of such seasonal trends existing in Cottonwood Creek. It is obvious that the substrates at the two sites are quite different, especially during the July and February sampling periods.

Some of the differences between the sediments at SW-1 and SW-2 are associated with the high carbonate content at location SW-2. The open exposure of the eastern bank of the stream at SW-2 and the lack of an overhead canopy combine to favor photosynthesis of algae. Under condition of very active photosynthesis, algae can switch from utilizing dissolved $CO_2$ in the water to utilizing carbon dioxide in the bicarbonate form. Extraction of $CO_2$ from the bicarbonate, $HCO_3^-$, leaves a hydroxide group ($OH^-$) which then reacts with other bicarbonates to form insoluble carbonate complexes. These complexes cement the substrate together in the form of a calcareous marl. The benthos of SW-2 was cemented in place by such a marl when samples were taken in July. Less cementing was noted when sampling in November and February. The lower marl presence in the fall and winter may be due to lower primary production associated with shorter days in the narrow canyon in which the sampling stations are located, or it may be an artifact resulting from the initial disturbance of the stream channel by the July sampling. The answer to this cannot be determined without further sampling. Station SW-1 did not have marl deposits during any of the sampling periods. This was to be expected because of the overhead canopy which would reduce the rate of algal photosynthesis.

The differences in the sediments collected from the two stations are summarized in Table IV. A comparison of sediment weight based on both modal and median weight frequencies also indicates the differences between stations SW-1 and SW-2. SW-2 samples in general had a smaller modal and median size although this difference is not apparent in the October samples. Diversity and evenness of each sample is also listed in Table IV. The diversity value gives a relative picture of the distribution of the sediment weights. The lower the diversity, the more a single size class dominates the sample. Again both diversity and evenness indicate that the sediments in station SW-1 are more skewed in distribution than are those in station SW-2 with the exception of the October sampling series.

Benthic Invertebrate Community

The benthic invertebrate community consisted of 15 taxa representing eight orders. The distributions of the invertebrates resulted in a high variance to mean ratio which implies a contagious distribution. Such patterns are typical of stream systems and the currently accepted treatment of such data is to utilize the geometric confidence limits based on a $\log(x+1)$ transformation on the arithmetic mean (Elliott, 1977; Shiozawa and Barnes,

1977). For that reason the confidence limits about each species will not be symmetrical. It is important to recognize that contagious distributions predominate in most benthic groups, and that this distributional pattern further limits the accuracy of small numbers of replicate samples.

The predominant benthic invertebrate groups collected included the mayflies, especially Baetis, perlodid and nemourid stoneflies, hydropsychid caddisflies, chironomids, simuliids and oligochaetes. These taxa can be placed into functional group designations (Cummins, 1974; Merritt and Cummins, 1978) which can add insight into the functional structures of the two sites. The stations can be compared over time as well as between each other for differences in functional groupings. The functional group concept of Cummins (1974) is based on the processing of food in the stream system. Most streams have a considerable portion of their energetic budget supplied by the surrounding riparian vegetation. The resulting food web is thus detrital based, and the functional groups correspond to the role which various species play in processing food within the system. Whole leaves, after being conditioned by bacteria and fungi are broken into smaller particles by shredders. The finer particles are collected from the flowing water by filterers, and those particles which settle out onto the stream bed are fed upon by the collector-gatherers. Grazers are those species which actively feed on living plant materials, algae being the main food source, while those designated as grazer/scrapers may also feed on epilithic detritus. Predators are those species which feed upon other benthic invertebrates.

In July SW-1 (Table V) had abundant collector-gatherers (Baetis, Chironomids, oligochaetes) and filter feeders (Brachycentrus, Hydropsyche and Prosimulium. Predators were represented by the plecopterans Cultus and Choloroperla, rhagionid fly larvae and the dytiscid beetle larvae, Agabus. The only shredder at SW-1 was Melanka (Plecoptera). The October (Table VI) samples had a decrease in shredder (still the one plecopteran species) and predator densities. The grazer/scraper Heptagenia (Ephemeroptera) occurred, possibly as a partial response to the open canopy following leaf drop and to the increased organic flocculates on the rock surfaces. The collector gatherers were in slightly lower densities. By February (Table VII) the collector gatherer Baetis was in low density but the chironomids, also collector gatherers, had increased to over ten times their October densities. The grazer Heptagenia was still present and the shredders were predominantly represented by Tipula and limnephilid caddisflies. The filterers were still present but the hydropsychid caddisflies decreased in density and the simuliid larvae became more abundant.

The July (Table VIII) samples from Station SW-2 had collector gatherer densities virtually identical to that of SW-1. The filter feeders were lower in density than those at station SW-1, but this difference was strongly influenced by the substrate size distribution. Filter feeders require a substratum for attachment and from the sediment analysis for SW-2 (Table I) it is apparent that the dominant substrate in July was gravel, too unstable for the development of a high filter feeder density. Shredders were also in lower densities in the SW-2 July samples, but with the high variance associated with the contagious distributions of this group the difference is not significant. The only predator in station SW-2 for July was the plecopteran Cultus. Its densities were approximately one fourth

Table IV. Sediment Data Summary

| Date: 7-31-85 | modal size | median size | Diversity | Evenness |
|---|---|---|---|---|
| SW-1 1 | 64+ | 64+ | 0.67201 | 0.323172 |
| SW-1 2 | 64+ | 64+ | 1.15532 | 0.555594 |
| SW-1 3 | 64+ | 64+ | 0.83994 | 0.403928 |
| SW-1 4 | 64+ | 64+ | 0.85902 | 0.413103 |
| mean conditions: | 64+ | 64+ | 0.92974* | 0.447111* |
| | | | | |
| SW-2 1 | 32-64 | 64+ | 1.45463 | 0.699529 |
| SW-2 2 | 8-32 | 32-64 | 1.91767 | 0.922209 |
| SW-2 3 | 8-32 | 8-32 | 0.91271 | 0.438922 |
| SW-2 4 | 8-32 | 8-32 | 1.11856 | 0.537914 |
| mean conditions | 8-32 | 8-32 | 1.63081* | 0.784255* |
| | | | | |
| Date: 10-25-85 | | | | |
| SW-1 1 | 64+ | 64+ | 1.20374 | 0.578878 |
| SW-1 2 | 64+ | 64+ | 0.69688 | 0.335131 |
| SW-1 3 | 64+ | 64+ | 0.88353 | 0.424889 |
| SW-1 4 | 32-64 | 64+ | 1.52695 | 0.734307 |
| mean conditions | 64+ | 64+ | 1.15095* | 0.553958* |
| | | | | |
| SW-2 1 | 8-32 | 8-32 | 1.28434 | 0.617639 |
| SW-2 2 | 64+ | 64+ | 0.92844 | 0.446487 |
| SW-2 3 | 64+ | 64+ | 1.06578 | 0.512532 |
| SW-2 4 | 64+ | 64+ | 0.54062 | 0.259986 |
| mean conditions | 64+ | 64+ | 1.25622* | 0.604112* |
| | | | | |
| Date 2-9-86 | | | | |
| SW-1 1 | 32-64 | 32-64 | 1.55692 | 0.748722 |
| SW-1 2 | 64+ | 64+ | 0.66529 | 0.319939 |
| SW-1 3 | 64+ | 64+ | 0.93986 | 0.451978 |
| SW-1 4 | 64+ | 64+ | 1.10446 | 0.531136 |
| mean conditions | 64+ | 64+ | 1.13801* | 0.547266* |
| | | | | |
| SW-2 1 | 8-32 | 8-32 | 1.32584 | 0.637594 |
| SW-2 2 | 64+ | 64+ | 0.81747 | 0.393120 |
| SW-2 3 | 8-32 | 8-32 | 0.84808 | 0.407840 |
| SW-2 4 | 8-32 | 8-32 | 1.33412 | 0.641577 |
| mean conditions | 8-32 | 8-32 | 1.446208* | 0.695475* |

* note that these values are based on the mean percent composition values from Tables I,II,III and are not arithmetic means of the individual diversity and evenness values.

Table V. Invertebrate density, diversity, evenness and biotic index for site SW-1, July 31, 1985.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 1754.52 | 716.11 | 4276.38 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 0.0 | - | - |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 185.68 | 76.12 | 433.37 |
| Chloroperlidae | | | |
| *Chloroperla sp.* | 8.07 | -4.51 | 45.98 |
| Nemouridae | | | |
| *Melanka sp.* | 51.13 | 0.93 | 316.72 |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 59.20 | 19.91 | 148.82 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 8.07 | -4.51 | 45.98 |
| Limnephillidae | 0.0 | - | - |
| Diptera | | | |
| Chironomidae | 142.62 | 24.69 | 652.80 |
| Rhagionidae | | | |
| *Athrix varigata* | 8.07 | -4.51 | 45.98 |
| Simuliidae | | | |
| *Prosimulium sp.* | 271.79 | 4.14 | 5347.37 |
| Tipulidae | | | |
| *Tipula sp.* | 0.0 | - | - |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 8.07 | -4.51 | 45.98 |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 274.48 | 60.42 | 1132.24 |
| Nematoda | 0.0 | - | - |
| Total Invertebrates | 2771.70 | | |

| | |
|---|---|
| Number of Taxa | 11 |
| H' Max | 2.397895 |
| Diversity, H' | 1.303748 |
| Evenness | 0.543705 |
| Biotic Index (Hilsenhoff 1977) | 2.0748 |

Table VI. Invertebrate density, diversity, evenness and biotic index for site SW-1, October 25, 1985.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 1178.65 | 498.96 | 2764.67 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 34.98 | 4.11 | 65.86 |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 64.58 | 2.00 | 433.92 |
| Chloroperlidae | | | |
| *Chloroperla sp.* | 86.11 | -3.56 | 1291.33 |
| Nemouridae | | | |
| *Melanka sp.* | 21.53 | -5.14 | 174.67 |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 86.11 | 27.19 | 236.51 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 0.0 | - | - |
| Limnephillidae | 0.0 | - | - |
| Diptera | | | |
| Chironomidae | 139.93 | 48.78 | 370.63 |
| Rhagionidae | | | |
| *Athrix variegata* | 21.53 | -5.14 | 174.67 |
| Simuliidae | | | |
| *Prosimulium sp.* | 13.45 | -4.94 | 89.97 |
| Tipulidae | | | |
| *Tipula sp.* | 0.0 | - | - |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 0.0 | - | - |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 365.97 | 184.75 | 715.17 |
| Nematoda | 8.07 | -4.51 | 45.98 |
| Total Invertebrates | 2020.92 | | |

| | |
|---|---|
| Number of Taxa | 11 |
| H' Max | 2.397895 |
| Diversity, H' | 1.410172 |
| Evenness | 0.588087 |
| Biotic Index (Hilsenhoff 1977) | 2.0719 |

Table VII. Invertebrate density, diversity, evenness and biotic index for site SW-1, February 9, 1986.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 861.11 | 161.00 | 4414.80 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 45.75 | 10.44 | 81.05 |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 26.91 | -0.17 | 53.99 |
| Chloroperlidae | | | |
| *Chloroperla sp.* | 24.22 | -1.47 | 49.91 |
| Nemouridae | | | |
| *Melanka sp.* | 8.07 | -4.51 | 45.98 |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 69.97 | 17.75 | 217.80 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 0.0 | - | - |
| Limnephillidae | 16.15 | -4.83 | 37.12 |
| Diptera | | | |
| Chironomidae | 4039.15 | 1675.14 | 9718.06 |
| Rhagionidae | | | |
| *Athrix varigata* | 0.0 | - | - |
| Simuliidae | | | |
| *Prosimulium sp.* | 91.49 | 2.94 | 752.20 |
| Tipulidae | | | |
| *Tipula sp.* | 29.60 | 1.20 | 58.00 |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 8.07 | -4.5 | 45.98 |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 129.17 | -3.24 | 2591.57 |
| Nematoda | 0.0 | - | - |
| Total Invertebrates | 5349.66 | | |

| | |
|---|---|
| Number of Taxa | 12 |
| H' Max | 2.484906 |
| Diversity, H' | 0.880037 |
| Evenness | 0.354153 |
| Biotic Index (Hilsenhoff 1977) | 2.0645 |

Table VIII. Invertebrate density, diversity, evenness and biotic index for site SW-2, July 31, 1985.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis* sp. | 1716.84 | 763.14 | 3845.84 |
| Heptageniidae | | | |
| *Heptagenia* sp. | 0.0 | - | - |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus* sp. | 45.75 | 0.43 | 274.62 |
| Chloroperlidae | | | |
| *Chloroperla* sp. | 0.0 | - | - |
| Nemouridae | | | |
| *Melanka* sp. | 37.67 | 0.58 | 196.02 |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche* sp. | 29.60 | -3.59 | 216.48 |
| Brachycentridae | | | |
| *Brachycentrus* sp. | 0.0 | - | - |
| Limnephillidae | 0.0 | - | - |
| Diptera | | | |
| Chironomidae | 129.17 | 46.62 | 330.47 |
| Rhagionidae | | | |
| *Athrix variegata* | 0.0 | - | - |
| Simuliidae | | | |
| *Prosimulium* sp. | 64.58 | 1.14 | 466.02 |
| Tipulidae | | | |
| *Tipula* sp. | 0.0 | - | - |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus* sp. | 0.0 | - | - |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 8.07 | -4.51 | 45.98 |
| Annellida | | | |
| Oligochaeta | 298.70 | 125.78 | 690.58 |
| Nematoda | 37.67 | -3.63 | 318.25 |
| Total Invertebrates | 2368.06 | | |

| | |
|---|---|
| Number of Taxa | 9 |
| H' Max | 2.197224 |
| Diversity, H' | 1.033331 |
| Evenness | 0.470289 |
| Biotic Index (Hilsenhoff 1977) | 2.3216 |

of that of the same species at SW-1.

In October (Table IX) the invertebrate density in SW-2 was double that of SW-1. Baetis was 2.5 times more abundant and the midge larvae (Chironomidae) were approximately ten times more abundant. Both the predacious stoneflies and the grazer Heptagenia were present in approximately the same density as in SW-1. The grazer was not present in SW-2 in July, and the change to more favorable substrate size classes are associated with its October occurrence. Filter feeders were less abundant. The simuliids appear to have undergone a fall emergence prior to the October sampling date and therefore were absent. The hydropsychid caddisflies were significantly lower in density than those in SW-1 for October, and were about the same density as they were in the previous SW-2 samples taken in July. The cause of this difference is not clear and the data taken in this project will not allow a resolution of this problem. One factor which could be influential is the lower drift rates of later instar hydropsychid caddisflies which slows dispersal and would therefore imply that later instar hydropsychids would be slow in colonizing newly opened habitat. However the ability of such behavioral factors to control densities several months later seems unlikely.

The February samples from SW-2 (Table X) are indicative of the stressful conditions which exist in the stream during the winter. At the time of sampling frazzle ice was present and it appeared that anchor ice had occurred as well. Invertebrate densities were approximately one eighth the October level. The location of SW-2 with its open exposure would increase the likelihood of anchor ice formation. In addition the sediments collected in February had shifted back to gravel (Table IV) which would also favor reduced numbers of species. The total invertebrate density in SW-2 was also about one eighth of that of SW-1 on that same sampling date. The functional groups present include mostly collector gatherers. A few filterers (hydropsychids) and shredders (Tipula) were collected, but in general the community appeared as a vagrant benthos with opportunistic species being dominant.

Diversity, evenness and the biotic index were also computed for the benthic communities. Highest diversity for SW-1 and SW-2 occurred during October. The lowest diversity for both stations occurred in February. SW-2 had the lowest diversity value in July and October samples but in February SW-1 was found to have the lowest diversity. At this time SW-2 had 6 taxa and SW-1 had 12 taxa but the evenness of SW-1 was much lower than that of SW-2. Wilhm (1970) proposed diversity indices less than one to be indicative of stressed or polluted systems while values above 3 represented clean water conditions. On this basis both stations are borderline polluted or polluted. Neither would fall into the clean water categories.

The biotic index, based on the computed values of Hilsenhoff (1972) was also used to compare the benthic communities. SW-2 had consistently higher biotic index values throughout the three sampling periods, averaging 2.3493 while SW-1 averaged 2.0704. Values between 0-2 are indicative of clean water conditions and values between 2 and 3 are indicative of sightly stressed conditions (Hilsenhoff 1972). Thus SW-1 is at worst very slightly stressed on the biotic index rating and SW-2 is only slightly but significantly more so. However much of the stress is can be attributed to the differences

Table IX. Invertebrate density, diversity, evenness and biotic index for site SW-2, October 25, 1985.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis* sp. | 2798.61 | 750.00 | 10363.83 |
| Heptageniidae | | | |
| *Heptagenia* sp. | 29.60 | -3.59 | 216.48 |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus* sp. | 129.17 | 2.66 | 1447.76 |
| Chloperlidae | | | |
| *Chloroperla* sp. | 40.36 | -3.63 | 355.72 |
| Nemouridae | | | |
| *Melanka* sp. | 0.0 | - | - |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche* sp. | 26.91 | 0.35 | 116.96 |
| Brachycentridae | | | |
| *Brachycentrus* sp. | 0.0 | - | - |
| Limnephillidae | 16.16 | -4.83 | 37.12 |
| Diptera | | | |
| Chironomidae | 1679.17 | 86.66 | 29303.24 |
| Rhagionidae | | | |
| *Athrix variegata* | 16.15 | -4.83 | 37.12 |
| Simuliidae | | | |
| *Prosimulium* sp. | 0.0 | - | - |
| Tipulidae | | | |
| *Tipula* sp. | 13.45 | -4.94 | 89.97 |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus* sp. | 8.07 | -4.51 | 45.98 |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 508.59 | 46.65 | 4687.38 |
| Nematoda | 21.53 | -5.14 | 174.67 |
| Total Invertebrates | 5287.77 | | |

| | |
|---|---|
| Number of Taxa | 12 |
| H' Max | 2.484906 |
| Diversity, H' | 1.192904 |
| Evenness | 0.480060 |
| Biotic Index (Hilsenhoff 1977) | 2.2651 |

Table X. Invertebrate density, diversity, evenness and biotic index for site SW-2, February 9, 1986.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 441.32 | 91.01 | 1997.33 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 0.0 | - | - |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 0.0 | - | - |
| Chloroperlidae | | | |
| *Chloroperla sp.* | 8.07 | -6.76 | 22.90 |
| Nemouridae | | | |
| *Melanka sp.* | 0.0 | - | - |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 8.07 | -4.51 | 45.98 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 0.0 | - | - |
| Limnephillidae | 0.0 | - | - |
| Diptera | | | |
| Chironomidae | 123.78 | -0.97 | 1837.34 |
| Rhagionidae | | | |
| *Athrix variegata* | 0.0 | - | - |
| Simuliidae | | | |
| *Prosimulium sp.* | 0.0 | - | - |
| Tipulidae | | | |
| *Tipula sp.* | 13.45 | -4.94 | 89.97 |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 0.0 | - | - |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 64.58 | -3.56 | 776.95 |
| Nematoda | 0.0 | - | - |
| Total Invertebrates | 659.29 | | |

| | |
|---|---|
| Number of Taxa | 6 |
| H' Max | 1.791759 |
| Diversity, H' | 0.997553 |
| Evenness | 0.556744 |
| Biotic Index (Hilsenhoff 1977) | 2.4612 |

of substrate size, a factor not fully considered in the derivation of the biotic index.

The final technique used to evaluate the samples was a form of multivariate analysis known as cluster analysis. Cluster analysis utilizes a similarity matrix based on comparisons of all possible pairs of samples in the study. The similarity can be measured with any index, including those based on presence and absence as well as on quantitative comparisons. In this study correlation coefficients were used as the measure of similarity. The resulting correlation matrices are listed in Tables XI and XII. Table XI lists the correlations of all possible pairs of sediment samples and Table XII lists the correlations for all pairs of benthic invertebrate samples. Cluster dendrograms for the sediments (Figure 1) and the benthic invertebrate communities (Figure 2) were prepared from the correlation matrices. The algorithm used was the unweighted pair-group arithmetic averaging method (Sokal and Sneath, 1963; Sneath and Sokal, 1973). The initial purpose of clustering was to check for associations between the sediments and samples. The high degree of sediment variability between the stations as well as within station SW-2 over time made it necessary to look for associations between the sediment structure of a sample and invertebrate community structure. That is, to determine if sediment-invertebrate community structure was tightly enough linked that community structure could be determined solely on the sediment structure of the sample. Discrete multivariate comparisons of categorized groupings showed no significant associations between sediment structure and community structure. This should not be interpreted to imply that no association exists. The earlier discussions of various functional groups did develop the concept of functional associations, but the results of the cluster analysis point to no general response to the sediment composition by the community as a unit. The various species involved in the system act independently of one another in their responses to the ambient conditions.

The clusters can also be used to distinguish patterns within the clustered samples. The sediment cluster (Figure 1) can be subdivided into three clusters at the similarity level of 0.55. The samples which make up the first cluster consist of SW-2 samples exclusively, and the third cluster is comprised of two samples from SW-2 taken in July. The second cluster contains all of the SW-1 samples as well as most of the October SW-2 samples. This indicates that the samples from SW-2 are much more variable than those from SW-1, and that the October SW-2 samples did converge towards the sediment distribution typical of the upstream site, SW-1. This interpretation confirms the earlier discussion of sediment size structure, with an additional observation that two of the July samples from SW-2 (sample #'s 1 and 2) were quite different from those taken from the same site in July and February.

The benthic invertebrate cluster (Figure 2) is more difficult to interpret. In general the July samples from SW-1 and SW-2 tend to be quite similar and the SW-2 February samples tend to also fall within this cluster. However the samples from SW-1 in February are very different from the patterns found at that station during the other two sampling periods. Since the samples all fall in a single discrete cluster, a seasonal succession in the community structure at SW-1 is implied. Such dynamics are not as

Table XI. Correlation matrix of percent sediment composition.

| July 1985 SW-1 1 | July 1985 SW-1 2 | July 1985 SW-1 3 | July 1985 SW-1 4 | July 1985 SW-2 1 | July 1985 SW-2 2 | July 1985 SW-2 3 | July 1985 SW-2 4 | October 1985 SW-1 1 | October 1985 SW-1 2 | October 1985 SW-1 3 | October 1985 SW-1 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | | | | | | | | | | | |
| 0.984 | 1.000 | | | | | | | | | | |
| 0.998 | 0.992 | 1.000 | | | | | | | | | |
| 0.987 | 0.961 | 0.976 | 1.000 | | | | | | | | |
| 0.685 | 0.802 | 0.728 | 0.622 | 1.000 | | | | | | | |
| 0.288 | 0.445 | 0.347 | 0.212 | 0.869 | 1.000 | | | | | | |
| -0.129 | -0.059 | -0.137 | -0.021 | 0.126 | 0.216 | 1.000 | | | | | |
| -0.137 | 0.032 | -0.090 | -0.157 | 0.567 | 0.803 | 0.639 | 1.000 | | | | |
| 0.945 | 0.981 | 0.954 | 0.936 | 0.845 | 0.523 | 0.130 | 0.188 | 1.000 | | | |
| 0.994 | 0.985 | 0.997 | 0.964 | 0.717 | 0.335 | -0.207 | -0.127 | 0.935 | 1.000 | | |
| 0.999 | 0.983 | 0.996 | 0.992 | 0.680 | 0.282 | -0.101 | -0.133 | 0.948 | 0.990 | 1.000 | |
| 0.923 | 0.959 | 0.929 | 0.929 | 0.827 | 0.508 | 0.188 | 0.190 | 0.986 | 0.906 | 0.930 | 1.000 |
| -0.176 | -0.012 | -0.135 | -0.177 | 0.519 | 0.745 | 0.701 | 0.982 | 0.152 | -0.175 | -0.167 | 0.184 |
| 0.994 | 0.998 | 0.998 | 0.974 | 0.759 | 0.387 | -0.091 | -0.035 | 0.970 | 0.993 | 0.993 | 0.946 |
| 0.888 | 0.913 | 0.886 | 0.920 | 0.738 | 0.415 | 0.337 | 0.202 | 0.965 | 0.850 | 0.900 | 0.965 |
| 0.992 | 0.966 | 0.982 | 0.999 | 0.628 | 0.219 | -0.051 | -0.163 | 0.937 | 0.972 | 0.995 | 0.924 |
| 0.938 | 0.966 | 0.942 | 0.947 | 0.804 | 0.471 | 0.190 | 0.164 | 0.992 | 0.917 | 0.945 | 0.995 |
| 0.998 | 0.970 | 0.991 | 0.991 | 0.635 | 0.225 | -0.143 | -0.197 | 0.925 | 0.987 | 0.998 | 0.907 |
| 0.998 | 0.994 | 0.999 | 0.982 | 0.730 | 0.347 | -0.099 | -0.075 | 0.962 | 0.994 | 0.997 | 0.942 |
| 0.951 | 0.990 | 0.966 | 0.921 | 0.872 | 0.555 | 0.009 | 0.168 | 0.990 | 0.956 | 0.949 | 0.964 |
| -0.172 | -0.004 | -0.125 | -0.189 | 0.535 | 0.795 | 0.646 | 0.998 | 0.154 | -0.162 | -0.167 | 0.158 |
| 0.998 | 0.978 | 0.993 | 0.993 | 0.661 | 0.252 | -0.108 | -0.158 | 0.939 | 0.987 | 0.999 | 0.924 |
| -0.113 | -0.015 | -0.108 | -0.021 | 0.246 | 0.355 | 0.987 | 0.750 | 0.178 | -0.175 | -0.084 | 0.229 |
| 0.113 | 0.219 | 0.121 | 0.185 | 0.462 | 0.504 | 0.937 | 0.782 | 0.403 | 0.055 | 0.136 | 0.444 |

| October 1985 SW-2 1 | October 1985 SW-2 2 | October 1985 SW-2 3 | October 1985 SW-2 4 | February 1986 SW-1 1 | February 1986 SW-1 2 | February 1986 SW-1 3 | February 1986 SW-1 4 | February 1986 SW-2 1 | February 1986 SW-2 2 | February 1986 SW-2 3 | February 1986 SW-2 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | | | | | | | | | | | |
| -0.079 | 1.000 | | | | | | | | | | |
| 0.186 | 0.905 | 1.000 | | | | | | | | | |
| -0.190 | 0.979 | 0.912 | 1.000 | | | | | | | | |
| 0.148 | 0.957 | 0.980 | 0.942 | 1.000 | | | | | | | |
| -0.230 | 0.984 | 0.876 | 0.995 | 0.923 | 1.000 | | | | | | |
| -0.113 | 0.999 | 0.903 | 0.987 | 0.954 | 0.991 | 1.000 | | | | | |
| 0.118 | 0.978 | 0.919 | 0.926 | 0.968 | 0.928 | 0.968 | 1.000 | | | | |
| 0.980 | -0.070 | 0.173 | -0.195 | 0.131 | -0.231 | -0.110 | 0.132 | 1.000 | | | |
| -0.188 | 0.989 | 0.893 | 0.996 | 0.939 | 0.999 | 0.995 | 0.940 | -0.193 | 1.000 | | |
| 0.801 | -0.057 | 0.357 | -0.048 | 0.225 | -0.134 | -0.071 | 0.070 | 0.754 | -0.096 | 1.000 | |
| 0.816 | -0.174 | 0.550 | 0.161 | 0.440 | 0.082 | 0.156 | 0.307 | 0.778 | 0.121 | 0.970 | 1.000 |

Table XII. Correlation matrix of the benthic communities.

| July 1985 SW-1 1 | July 1985 SW-1 2 | July 1985 SW-1 3 | July 1985 SW-1 4 | July 1985 SW-2 1 | July 1985 SW-2 2 | July 1985 SW-2 3 | July 1985 SW-2 4 | October 1985 SW-1 1 | October 1985 SW-1 2 | October 1985 SW-1 3 | October 1985 SW-1 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | | | | | | | | | | | |
| 0.718 | 1.000 | | | | | | | | | | |
| 0.987 | 0.729 | 1.000 | | | | | | | | | |
| 0.966 | 0.762 | 0.986 | 1.000 | | | | | | | | |
| 0.958 | 0.786 | 0.980 | 0.990 | 1.000 | | | | | | | |
| 0.941 | 0.875 | 0.959 | 0.967 | 0.983 | 1.000 | | | | | | |
| 0.976 | 0.752 | 0.997 | 0.990 | 0.989 | 0.971 | 1.000 | | | | | |
| 0.927 | 0.861 | 0.957 | 0.958 | 0.960 | 0.973 | 0.962 | 1.000 | | | | |
| 0.942 | 0.779 | 0.966 | 0.983 | 0.985 | 0.967 | 0.976 | 0.956 | 1.000 | | | |
| 0.934 | 0.849 | 0.960 | 0.969 | 0.979 | 0.983 | 0.969 | 0.980 | 0.983 | 1.000 | | |
| 0.612 | 0.953 | 0.637 | 0.645 | 0.698 | 0.808 | 0.665 | 0.789 | 0.684 | 0.765 | 1.000 | |
| 0.946 | 0.845 | 0.973 | 0.969 | 0.979 | 0.987 | 0.979 | 0.994 | 0.970 | 0.986 | 0.782 | 1.000 |
| 0.956 | 0.802 | 0.977 | 0.992 | 0.998 | 0.984 | 0.986 | 0.965 | 0.988 | 0.985 | 0.702 | 0.979 |
| 0.692 | 0.539 | 0.761 | 0.689 | 0.690 | 0.697 | 0.755 | 0.794 | 0.679 | 0.725 | 0.575 | 0.780 |
| 0.731 | 0.504 | 0.798 | 0.729 | 0.725 | 0.711 | 0.789 | 0.807 | 0.718 | 0.748 | 0.519 | 0.797 |
| 0.372 | 0.352 | 0.449 | 0.351 | 0.363 | 0.404 | 0.443 | 0.527 | 0.352 | 0.427 | 0.474 | 0.501 |
| 0.230 | 0.158 | 0.302 | 0.190 | 0.192 | 0.222 | 0.288 | 0.360 | 0.185 | 0.252 | 0.290 | 0.541 |
| 0.012 | -0.060 | 0.084 | -0.032 | -0.034 | -0.013 | 0.067 | 0.136 | -0.038 | 0.024 | 0.089 | 0.332 |
| 0.466 | 0.265 | 0.539 | 0.437 | 0.432 | 0.430 | 0.523 | 0.559 | 0.425 | 0.468 | 0.346 | 0.104 |
| 0.140 | 0.027 | 0.216 | 0.104 | 0.099 | 0.111 | 0.199 | 0.261 | 0.094 | 0.151 | 0.156 | 0.231 |
| 0.849 | 0.791 | 0.902 | 0.866 | 0.884 | 0.910 | 0.909 | 0.948 | 0.869 | 0.913 | 0.796 | 0.946 |
| 0.942 | 0.737 | 0.982 | 0.967 | 0.972 | 0.954 | 0.985 | 0.969 | 0.960 | 0.962 | 0.677 | 0.980 |
| 0.935 | 0.684 | 0.957 | 0.967 | 0.969 | 0.930 | 0.962 | 0.907 | 0.983 | 0.956 | 0.580 | 0.929 |
| 0.958 | 0.705 | 0.985 | 0.989 | 0.989 | 0.953 | 0.989 | 0.940 | 0.984 | 0.966 | 0.606 | 0.960 |

| October 1985 SW-2 1 | October 1985 SW-2 2 | October 1985 SW-2 3 | October 1985 SW-2 4 | February 1986 SW-1 1 | February 1986 SW-1 2 | February 1986 SW-1 3 | February 1986 SW-1 4 | February 1986 SW-2 1 | February 1986 SW-2 2 | February 1986 SW-2 3 | February 1986 SW-2 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | | | | | | | | | | | |
| 0.681 | 1.000 | | | | | | | | | | |
| 0.715 | 0.992 | 1.000 | | | | | | | | | |
| 0.352 | 0.915 | 0.871 | 1.000 | | | | | | | | |
| 0.418 | 0.840 | 0.798 | 0.977 | 1.000 | | | | | | | |
| 0.179 | 0.697 | 0.654 | 0.904 | 0.972 | 1.000 | | | | | | |
| -0.048 | 0.945 | 0.932 | 0.966 | 0.957 | 0.822 | 1.000 | | | | | |
| 0.085 | 0.785 | 0.751 | 0.941 | 0.989 | 0.990 | 0.938 | 1.000 | | | | |
| 0.879 | 0.923 | 0.916 | 0.744 | 0.601 | 0.397 | 0.751 | 0.506 | 1.000 | | | |
| 0.968 | 0.829 | 0.858 | 0.547 | 0.399 | 0.185 | 0.621 | 0.315 | 0.947 | 1.000 | | |
| 0.972 | 0.651 | 0.704 | 0.310 | 0.157 | -0.055 | 0.410 | 0.078 | 0.825 | 0.944 | 1.000 | |
| 0.987 | 0.713 | 0.760 | 0.379 | 0.225 | 0.010 | 0.477 | 0.145 | 0.871 | 0.977 | 0.988 | 1.000 |

Figure I

Sediment cluster

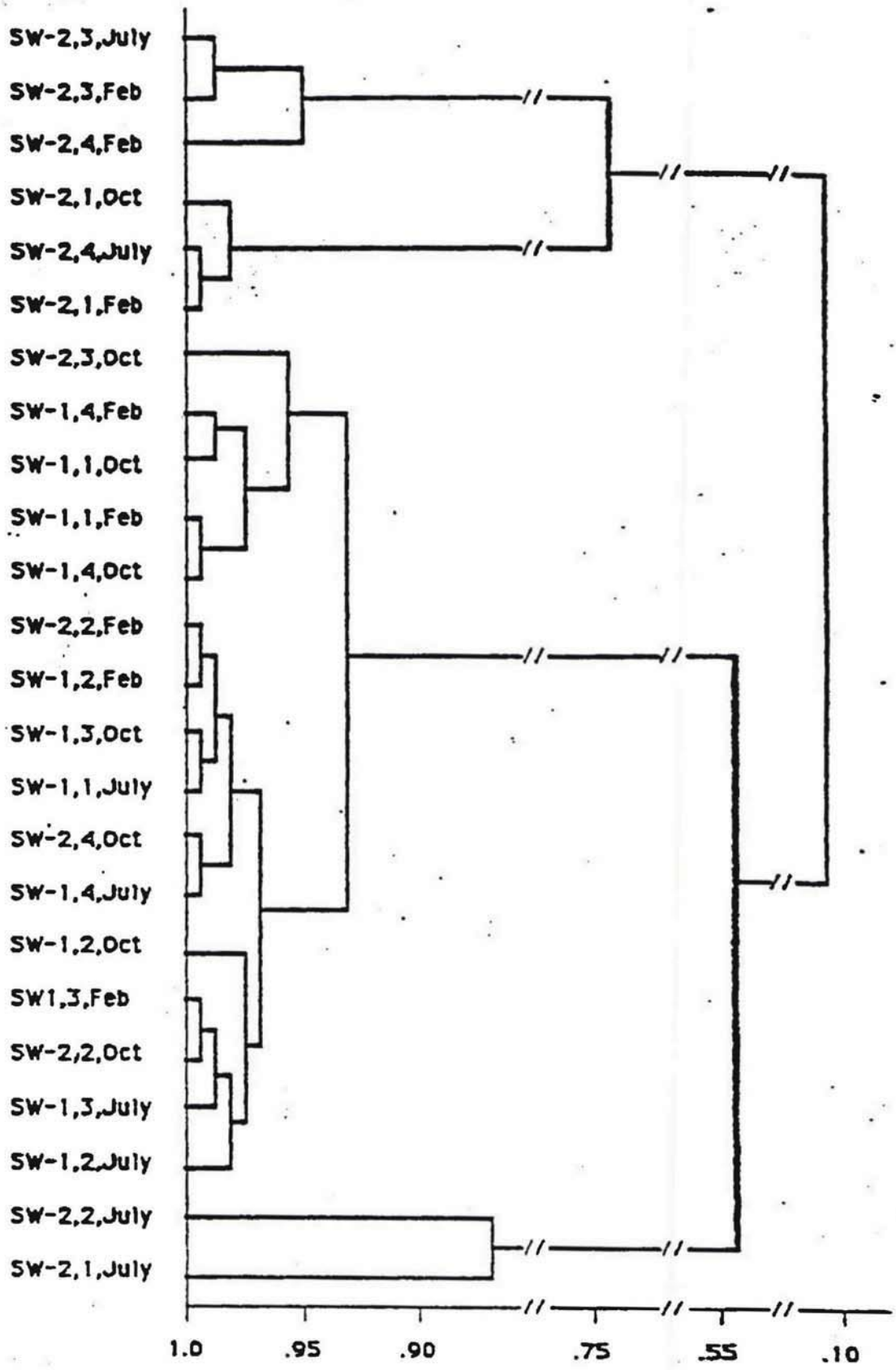
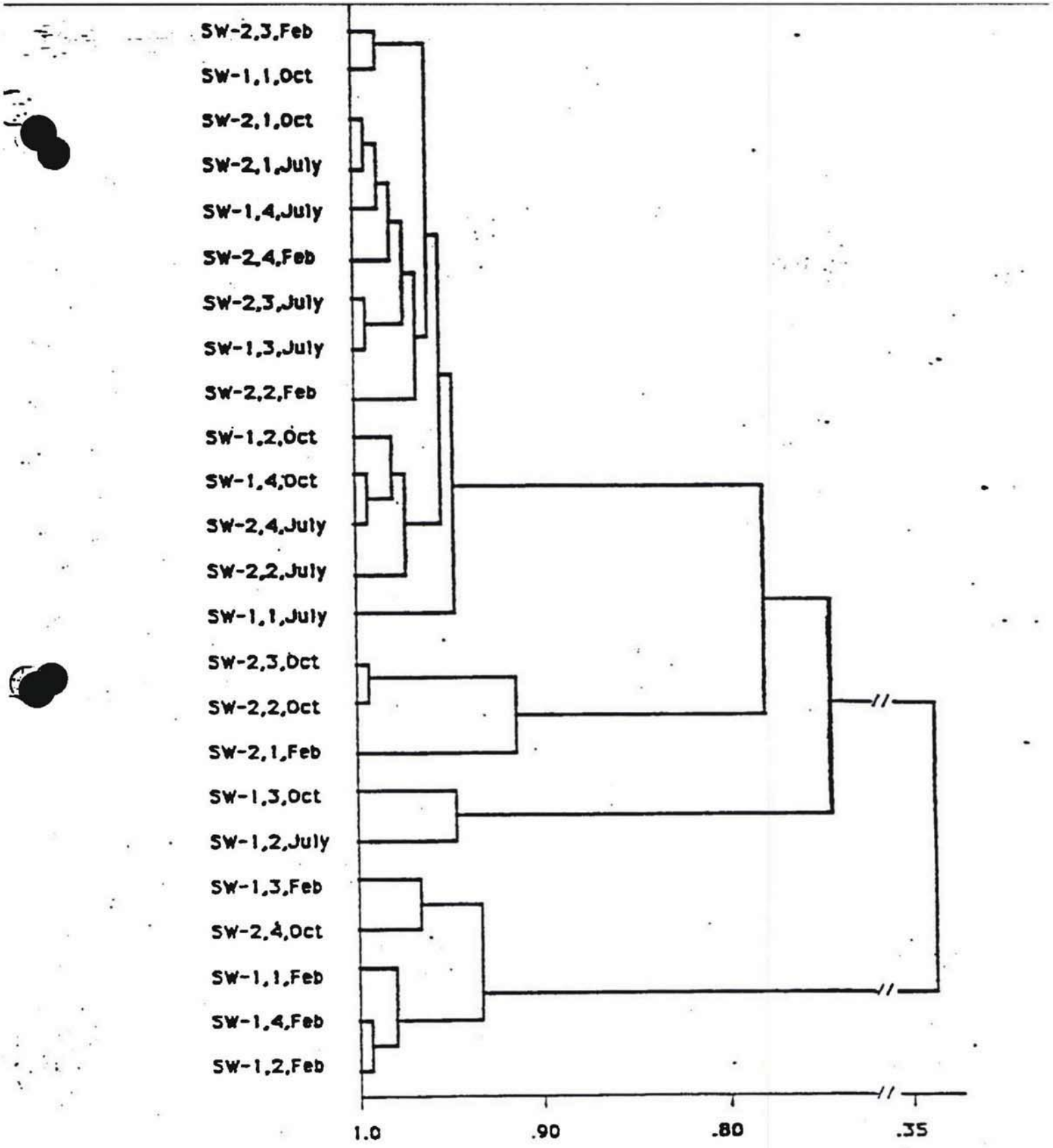

SW-2,3,July
SW-2,3,Feb
SW-2,4,Feb
SW-2,1,Oct
SW-2,4,July
SW-2,1,Feb
SW-2,3,Oct
SW-1,4,Feb
SW-1,1,Oct
SW-1,1,Feb
SW-1,4,Oct
SW-2,2,Feb
SW-1,2,Feb
SW-1,3,Oct
SW-1,1,July
SW-2,4,Oct
SW-1,4,July
SW-1,2,Oct
SW1,3,Feb
SW-2,2,Oct
SW-1,3,July
SW-1,2,July
SW-2,2,July
SW-2,1,July
1.0
.95
.90
.75
.55
.10

Figure II

Benthic community cluster


SW-2,3,Feb
SW-1,1,Oct
SW-2,1,Oct
SW-2,1,July
SW-1,4,July
SW-2,4,Feb
SW-2,3,July
SW-1,3,July
SW-2,2,Feb
SW-1,2,Oct
SW-1,4,Oct
SW-2,4,July
SW-2,2,July
SW-1,1,July
SW-2,3,Oct
SW-2,2,Oct
SW-2,1,Feb
SW-1,3,Oct
SW-1,2,July
SW-1,3,Feb
SW-2,4,Oct
SW-1,1,Feb
SW-1,4,Feb
SW-1,2,Feb
1.0
.90
.80
.35

clear from station SW-2, likely because of the sediment variability over time which complicates interpretation of any existing trends.

## Conclusions

The data gathered for this study have not yielded discrete answers to the impact or degree of impact of the Trail Mountain Coal Company Mining operation on Cottonwood Creek but an evaluation of the various analytical methods used do allow a conclusion to be reached. The general trends shown by the diversity values and the biotic index do point towards some impact on the downstream station, however that impact, if real, is minor. Additional factors need to be considered. 1) Sediment analysis showed that the lower station underwent greater seasonal changes than did the upper station. It is significant that the predominant sediment type at SW-2 was gravel. This substrate size is less stable than the rubble habitat found at station SW-1, and thus the differences seen between SW-1 and SW-2 communities could be a function of the sediment structure and completely independent of any mining impact. 2) It is also notable that in February the diversity value at SW-1 was actually lower than that at SW-2, implying that if diversity alone were the judgement tool, SW-2 at that time was in better condition than is the upstream SW-1. The location of a road paralleling Cottonwood Creek above SW-1 will also stress the stream independently of the Trail Mountain Mining operation. 3) Observations made when sampling began in July included the presence of a calcarious marl in the sediments at SW-2. Whether sampling sufficiently disturbed this marl and thus initiated the shift in sediment structure observed in October is not known, but must be retained as a possibility. 4) The degree of development of various functional groups differed between the two sites. In particular the filter feeders and grazers are strongly influenced by substrate size since unstable substrates have a lower standing crop of algae and are not good anchoring sites for filter feeders. Different substrate sizes will also influence the settling and retention of different sizes of detrital particles and thus influence the densities and species composition of the shredder groups in the substrate.

In general the differences between the two stations can be sufficiently explained by differences in sediment structure. The higher biotic index values of SW-2, while consistently above that of SW-1, are associated with the microhabitat created in a gravel environment as opposed to a rubble area. The benthic inhabitants of gravel tend to be those which have been given higher biotic index values. This relates to their ability to live under less turbulent (and thus less oxygenated) conditions. The biotic index does not consider variations in substrate type, other than assuming that samples will be taken from the most coarse substrate available. This results in an index which is robust and more reliable than diversity indices, but which can confound the effects of sediment structure and thus give biased results.

Therefore I am concluding that the impact of the Trail Mountain mining operation on the Cottonwood Creek invertebrate community is negligible as determined by the prescribed sampling program. Because of various confounding factors unanticipated in the original design of the study, a more direct conclusion is not possible. It does not appear that additional studies

need to be conducted, however if further sampling is required I recommend that several changes be made in the prescribed methodology. First, care should be taken to select a downstream station with canopy cover, sediments and slope conditions comparable to that at station SW-1. This will allow the elimination of the marl as a confounding variable. The taking of four replicate samples is often standard, but usually results in too few samples to give strong statistical confidence in the results of the study. More samples should be taken per station. More frequent sampling will allow a more accurate assessment of seasonal events, and in some ways reduce the extrapolation necessary to interpret results, but monthly sampling is probably not necessary. It also appears that winter samples may not be as useful as samples taken during the warmer months.

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BENTHIC MACROINVERTIBRATES

REQUEST TO DISCONTINUE SAMPLING

Appendix 7-123

# REQUEST TO DISCONTINUE MACROINVERTIBRATE SAMPLING ON COTTONWOOD CREEK

Based on the conclusions of Dr. Dennis Shiozawa and his work on sampling the macroinvertibrate community in the Cottonwood Creek and the Division of Wildlife Resource letter dated November 25, 1986 concurring with Dr. Shizawa that additional studies are not necessary, we would formally request of the division to discontinue any further macroinvertibrate sampling.

STATE OF UTAH
NATURAL RESOURCES
Wildlife Resources

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
William H. Geer, Division Director

Southeastern Region • 455 West Railroad Avenue • Price, UT 84501-2829 • 801-637-3310

November 25, 1986

Mr. Allen Childs
Trail Mountain Coal Company
P.O. Box 370
Orangeville, UT 84537

Dear Allen:

As per your request, the Division has reviewed the final report for "Cottonwood Creek Macroinvertebrate Assessment" as prepared by Dennis K. Shiozawa in the Department of Zoology at Brigham Young University. The differences in substrate and vegetation overstory between the two sample sites is substantial. This diminishes our ability to evaluate differences between control and experimental (potential impact area) data. The small number of replicate samples would also confound an evaluation if the control and experimental sites were more closely matched.

Considering that control and experimental sites each showed diversity indices suggestive of polluted systems and the biotic index showed the experimental and control to be slightly stressed, mining is not likely a measurable influence on the stream system. As a result, we concur with the author that additional studies relative to mining are not necessary.

Thank you for the opportunity to review and provide comment.

Sincerely

John Livesay, Supervisor
Southeastern Region

JL/LBD/dd

cc: Kathy Mutz
Darrell Nish

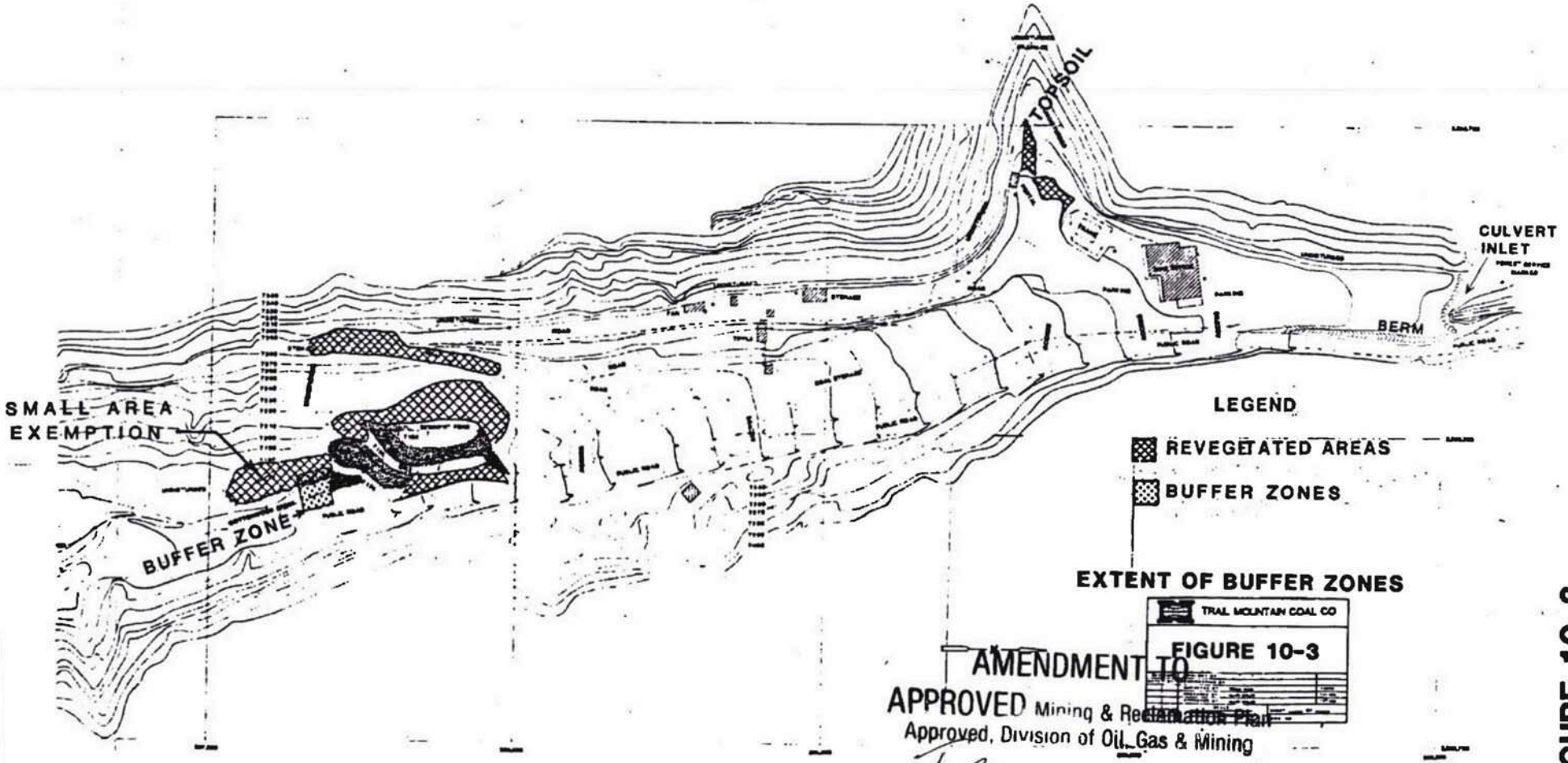

TOPSOIL
CULVERT INLET
BERM
SMALL AREA EXEMPTION
BUFFER ZONE
LEGEND
REVEGETATED AREAS
BUFFER ZONES
EXTENT OF BUFFER ZONES
TRAIL MOUNTAIN COAL CO
FIGURE 10-3
AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by
date REVISED 6/2/98

FIGURE 10-3

# APPENDIX 3-10-8 (L)

# DEFINITION AND EXPLANATION OF WILDLIFE RANGE AREAS ON FIGURE 10-4

Beaver Creek Coal Company
Trail Mountain No.9 Mine
Lease Permit Appliation

# APPENDIX 10-8(L)

# DEFINITION AND EXPLANATION

# OF

# WILDLIFE RANGE AREAS

# ON

# FIGURE 10-4

3/11/91

## Definition and Explanation of Wildlife Range Areas as Referenced on Figure 10-4

Determination of Wildlife Range Areas were supplied by the Utah Division of Wildlife Resources Southeast Regional office, Price, Utah. Range areas are determined by species, and a number of species will concurrently occupy the same area. Beaver Creek Coal has delineated those species which are considered primary or of high importance due to their high interest in association with recreational hunting. Those species are the Mule deer and Rocky Mountain elk.

A ranking system was developed by UDWR in order to prioritize typical or continued use by a number of species. The methodology used to determine range area is: (1) through review of historical data relative to the presence of the species; (2) current biological census information collected continually by UDWR biologists; (3) evaluation of species of vegetation and a determination of their value and or importance to wildlife; (4) the presence of life constituents, particularly to each species such as water, cover etc.; and (5) the physical presence of the species at prescribed periods of the year.

Ranking of relative biological value for ecosystems to animals is as follows:

(C) critical - an area that provides for "sensitive" biological/and behavioral requisites necessary to sustain the existence and/or perpetuation of one or more wildlife species during crucial time periods in their life cycles.

(H) high-priority - an area that provides for "intensive" use by one or more wildlife species.

(S) substantial - an area that provides for "frequent" use by one or more wildlife species.

(L) low or limited - an area that provides for only "occasional" use by one or more wildlife species.

In addition to the terrestrial wildlife within and adjacent to the Permit Area, the aquatic resource was also evaluated. The only fishery of consequence that could theoretically be impacted through mining is Cottonwood Creek - Straight Canyon. The following information was supplied by the Utah Division of Wildlife Resources and is based on their inventory and classification of the entire area of Straight Canyon which could be influenced directly from mining or indirectly from modification of flows as a result of mining.

| (e) Aquatic Resources | Crucial Critical Use Area | High Priority Use Area | Substantial Value Use Area |
|---|---|---|---|
| Green River Drainage | | | |
| Cottonwood Creek II.AI.140. (Straight Canyon - Manti Mountain) | Joe's Valley Resivoir done 5.5 miles c-cw-3-2-y1 Species: 1,3,21,43,27,28, 29,60 | 5.5 miles to 8.3 miles h-cw-2-3-y1 Species: 3,21,27,28,29, 43,60 | 8.3 miles to 24 miles s-cw-1-4-y1 Species: 21,27,28,29,52 ,60 |
| | | | |

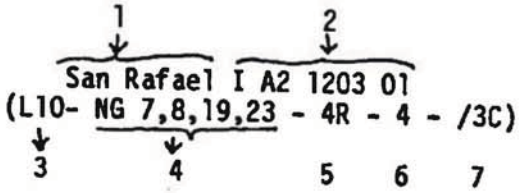
A key as to classification is attached ad well as a key to Utah fishes.

At this point, no adverse impacts to this aquatic resource are anticipated.

3/11/91

## KEY TO STREAM DESIGNATIONS ON OVERLAYS

Example:




1. Stream Name

2. Stream number designating stream order.

Examples:

| | | | | |
|---|---|---|---|---|
| I | AK | 2003 | | |
| 1st ord. | 2nd ord. | 3rd ord. | | |
| II | AK | 2003 | A | 02 |
| 2nd ord. | 3rd ord. | 4th ord. | 5th ord. | 6th ord. |
| I | AK | 2003 | 02 | |
| 1st ord. | 2nd ord. | 3rd ord. | 4th ord. | |

3. Stream value

C = Critical (Class 1 & 2 streams)
H = High Priority (Class 3 streams)
S = Substantial (Class 4 streams)
L = Limited (Class 5 & 6 streams)
Stream miles of that section with that value

4. Management Priority

CW = Cold water fisheries
WW = Warm water fisheries
NG = Nongame
CL = Cool water
Fish Species found in that stream section (see fish species codes)

5. Stream Classification

1. Top quality
2. Great importance
3. Important
4. Poor quality
5. Valueless
6. Dewatered for long periods

Importance according to:
R Spawning area
N Nursery area

B Both spawning & nursery
X threatened & endangered

6 Stream Section*

The lower the number the closer to confluence

7. AD = Anti degradation designation
/ = Not designated as anti degradation
Health Code numbers (such as 3c)

* )—( symbol on maps designates stream section boundaries

APPENDIX H

## CODES FOR UTAH FISHES[1]

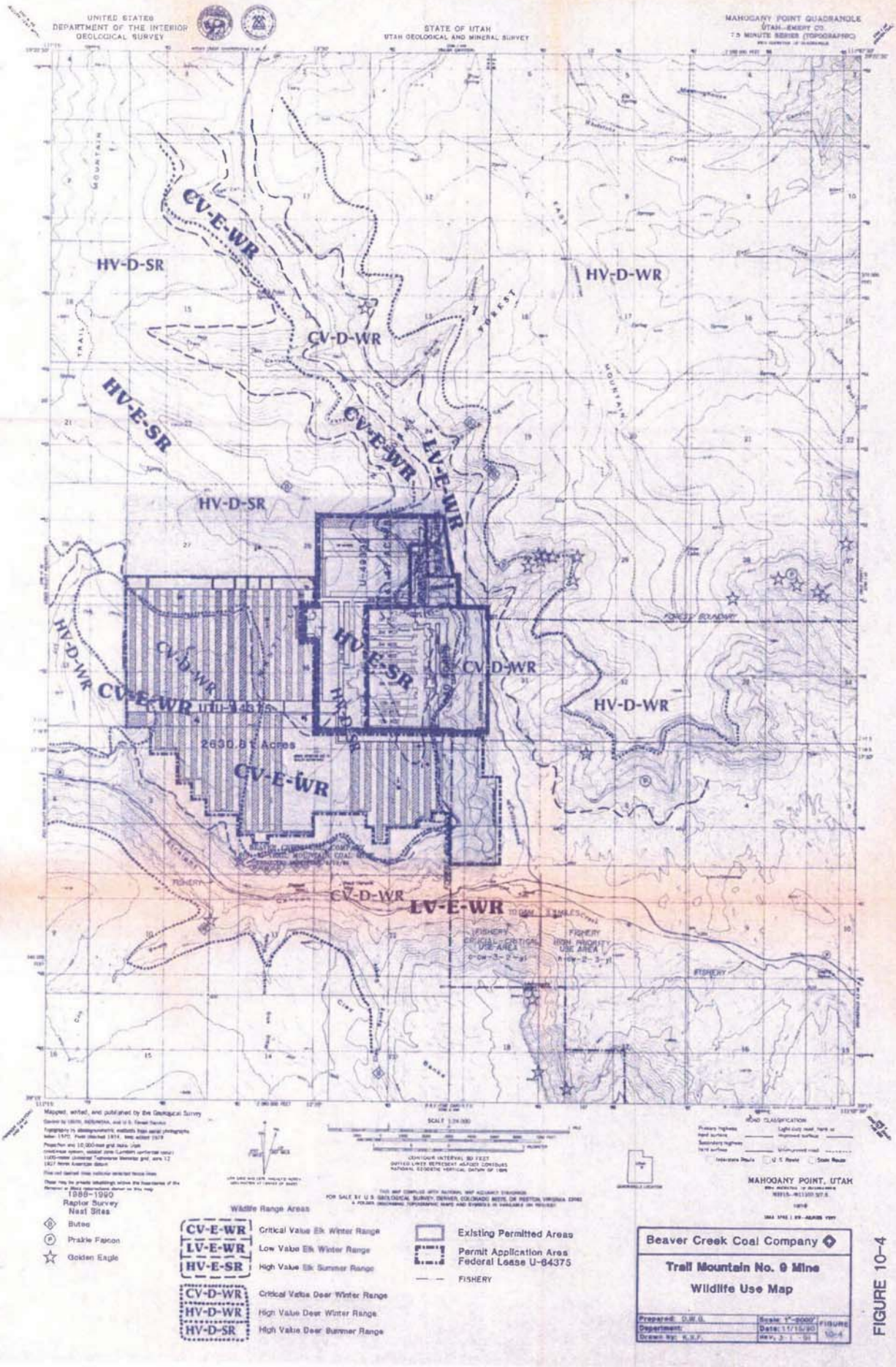
| Code no. | Common name | Scientific name |
|---|---|---|
| 01 | Rainbow trout | Salmo gairdneri |
| 02 | Cutthroat trout (Yellowstone) | Salmo clarki |
| 03 | Brown trout | Salmo trutta |
| 04 | Brook trout | Salvelinus fontinalis |
| 05 | Lake trout | Salvelinus namaycush |
| 06 | Kokanee (sockeye) | Oncorhynchus nerka |
| 07 | Channel catfish | Ictalurus punctatus |
| 08 | Black bullhead | Ictalurus melas |
| 09 | Yellow bullhead | Ictalurus natalis |
| 10 | Golden trout | Salmo aguabonita |
| 11 | Bonneville cisco | Prosopium gemmiferum |
| 12 | Albino rainbow trout | Salmo gairdneri |
| 13 | Arctic grayling | Thymallus arcticus |
| 14 | Carp | Cyprinus carpio |
| 15 | Utah chub | Gila atraria |
| 16 | Bonytail chub | Gila elegans |
| 17 | Leatherside chub | Gila copei |
| 18 | Redside shiner | Richardsonius balteatus |
| 19 | Colorado squawfish | Ptychocheilus lucius |
| 20 | Least chub | Iotichthys phlegethontis |
| 21 | Speckled dace | Rhinichthys osculus |
| 22 | Longnose dace | Rhinichthys cataractae |
| 23 | Fathead minnow | Pimephales promelas |
| 24 | Virgin River spinedace | Lepidomeda mollispinis |
| 25 | Woundfin | Plagopterus argentissimus |
| 26 | Utah sucker | Catostomus ardens |
| 27 | Flannelmouth sucker | Catostomus latipinnis |
| 28 | Mountain sucker | Catostomus platyrhinchus |
| 29 | Bluehead sucker | Catostomus discobolus |
| 30 | Green sucker | Pantosteus virescens (2) |
| 31 | Razorback sucker | Xyrauchen texanus |
| 32 | Plains killifish | Fundulus zebrinus |
| 33 | Rainwater killifish | Lucania parva |
| 34 | Mosquitofish | Gambusia affinis |
| 35 | White bass | Morone chrysops |
| 36 | Largemouth bass | Micropterus salmoides |
| 37 | Smallmouth bass | Micropterus dolomieui |
| 38 | Green sunfish | Lepomis cyanellus |
| 39 | Bluegill | Lepomis macrochirus |
| 40 | Black crappie | Pomoxis nigromaculatus |
| 41 | Yellow perch | Perca flavescens |

| | | |
|---|---|---|
| 42 | Walleye | Stizostedion vitreum |
| 43 | Mottled sculpin | Cottus bairdi |
| 44 | White crappie | Pomoxis annularis |
| 45 | Threadfin shad | Dorosoma petenense |
| 46 | Golden shiner | Notemigonus crysoleucus |
| 47 | Bear Lake whitefish | Prosopium abyssicola |
| 48 | Bonneville whitefish | Prosopium spilonotus |
| 49 | Sacramento perch | Archoplites interruptus |
| 50 | Striped bass | Morone saxatilis |
| 51 | Humpback chub | Gila cypha |
| 52 | Roundtail chub | Gila robusta |
| 53 | White sucker | Catostomus commersoni |
| 54 | Northern pike | Esox lucius |
| 55 | Red shiner | Notropis lutrensis |
| 56 | Sand shiner | Notropis stramineus |
| 57 | Bear Lake sculpin | Cottus extensus |
| 58 | Mountain whitefish | Prosopium williamsoni |
| 59 | Bonneville cutthroat trout | Salmo clarki Utah |
| 60 | Snake River cutthroat trout | Salmo clarki (subsp.) |
| 61 | Colorado River cutthroat trout | Salmo clarki pleuriticus |
| 62 | Bear Lake (Bonneville) cutthroat trout | Salmo clarki Utah |
| 63 | Lahontan cutthroat trout | Salmo clarki henshawi |
| 64 | Rainbow hybrid | Salmo sp. |
| 65 | Goldfish | Carassius auratus |
| 66 | Desert sucker | Catostomus clarki |
| 67 | Spottail shiner | Notropis hudsonius |
| 68 | Delta smelt | Hypomesus transpacificus nipponenis |
| 69 | Unknown Chub | |
| 70 | Crayfish | Orconectes causeyi |
| 71 | Creek chub | Semotilus atromaculatus |
| 72 | Virgin River chub | Gila robusta seminuda |
| 73 | June sucker | Chasmistes liorus |
| 74 | Brassy minnow | Hybognathus hankinsoni |
| 75 | Splake | Salvelinus fontinalis ♂ x Salvelinus namaycush ♀ |

1 Names taken frpm: American Fisheries Society, 1970. A list of common and scientific names of fishes from the U.S. and Canada Spec. Pub. No. 6.

2 The bluehead and green suckers are now recognized as being one species.

LAST UPDATED March 1, 1984


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
STATE OF UTAH
UTAH GEOLOGICAL AND MINERAL SURVEY
MAHOGANY POINT QUADRANGLE
UTAH—EMERY CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
CV-E-WR
HV-D-SR
HV-D-WR
CV-D-WR
HV-E-SR
LV-E-WR
HV-D-SR
HV-D-WR
CV-D-WR
CV-E-WR
U-43375
HV-E-SR
CV-D-WR
HV-D-WR
2630.81 Acres
CV-E-WR
CV-D-WR
LV-E-WR
FISHERY
FISHERY
FISHERY
Mapped, edited, and published by the Geological Survey
1980-1990
Raptor Survey
Nest Sites
Buteo
Prairie Falcon
Golden Eagle
Wildlife Range Areas
CV-E-WR
Critical Value Elk Winter Range
LV-E-WR
Low Value Elk Winter Range
HV-E-SR
High Value Elk Summer Range
CV-D-WR
Critical Value Deer Winter Range
HV-D-WR
High Value Deer Winter Range
HV-D-SR
High Value Deer Summer Range
Existing Permitted Areas
Permit Application Area
Federal Lease U-64375
FISHERY
MAHOGANY POINT, UTAH
Beaver Creek Coal Company
Trail Mountain No. 9 Mine
Wildlife Use Map
Prepared: D.W.G.
Department:
Drawn by: K.V.F.
Scale: 1"=2000'
Date: 11/15/90
Rev. 3-1-91
FIGURE 10-4

# CHAPTER 4
# LAND USE AND AIR QUALITY

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| 4-3 | Prime Farmland |
| 5-1 | Cultural and Historical Survey (incorporated into Appendix 4-1 - Confidential) |
| 5-1L | Archaeological Surveys (incorporated into Appendix 4-1 - Confidential) |
| 5-2 | Correspondence from the Utah Division of State History (incorporated into Appendix 4-1-Confidential) |

Yellow highlight signifies Text/Information Previously in Approved DOGM Permit, Moved and incorporated into Chapter 4 from previous Chapters 4 and 5). Red text within the yellow highlight is revised text. The un-highlighted text is new information being added to the permit document.

# CHAPTER 4
# Land Use and Air Quality

## 400 Land Use and Air Quality

This chapter of the mining and reclamation plan describes the status of lands in the mine plan permit and adjacent areas. Information used in preparing this chapter of the mining and reclamation plan has been gathered from published sources and from discussions with the relevant land-management agencies. Fossil Rock has leased the Cottonwood Tract Lease, although this lease will not be mined until permitted, certain baseline information associated with the lease is incorporated into the chapter.

## 410 Land Use

### 411 Environmental Description

The uses of land preceding mining were wildlife habitat and some limited grazing. Ranchers may have used the canyon for access to the upper parts of Cottonwood Canyon and the top of the plateau.

Within the permit area, acreage has been disturbed by the mine's surface facilities. The effect on vegetation associated with the facilities is temporary and will be eliminated by revegetation of the disturbance. Continued operation of the surface facilities will have no significant impact on the local wildlife. Discussions of the Waste Rock Disposal Site are found in a separate volume

of this M&RP.

### 411.100 Premining Land Use

Existing land uses of the Mine permit and adjacent areas consist of grazing, wildlife habitat, recreation, and industrial (mining, gas wells and gas pipelines). No commercial forest uses have existed on the privately owned or National Forest lands within the permit or adjacent areas. Farming is impractical due to the steep and rocky terrain, lack of water to irrigate and therefore, no future farm use is expected within the permit or adjacent area. The prime farmland determination information is in Appendix 4-3. Plate 4-1 shows the pre-mining land use for the permit and adjacent areas.

### 411.120 Land Capability

Recreation - Recreational use of the area consists primarily of sightseeing by people traveling up Cottonwood Canyon to the Upper Joes Valley area. Limited hunting also occurs on the mine plan area upon the plateau. Most of the area is characterized by steep and extremely rugged cliffs which are not conducive to recreational uses (Niebergall, 1981). There is no fishing in the canyon near the mine (Niebergall,1981). Access to the mine plan area is by the paved road in Cottonwood Canyon. Jeep trails allow access to the mine plan or adjacent areas on the high plateau above the Mine.

Bouldering has recently become a popular activity in the area adjacent to the mine. Emery County Recreation has listed 25 bouldering sites along Cottonwood Creek, both above and below the mine facilities. Wikipedia defines bouldering as a form of rock climbing that is performed on large boulders or other small rock formations, without the use of ropes or harnesses.

Farming - See Section 411.100.

Grazing - The National Forest land within the mine plan area is considered as unsuitable

range (Niebergall, 1981). Since 1981 when John Niebergall made the preceeding statement, additional area was added to the mine plan area. A map showing the US Forest Service grazing allotments is provided (see Plate 4-3). Livestock are also trailed on the road in Cottonwood Canyon (Niebergall, 1981). Cattle are moved to summer range at the higher elevations above the mine plan area.

In the past PacifiCorp has provided for the US Forest Service and the Trail Mountain Cattleman's Association, fences and gates at the Roan Canyon location and the adjacent Cottonwood Canyon location. The company (Pacificorp) has provided a cattle guard and a stock corral at the Cottonwood Canyon location, to aid the cattlemen in their efforts to trail cattle to and from summer ranges above the permitted areas.

As illustrated on Plate 4-3 the mine area lies primarily within a single grazing allotment, Trail Mountain C & H (cattle & horse). The Trail Mountain Allotment occupies 21,327 acres (of which 1,188 acres are Utah State lands) in northwestern Emery County. According to the Forest Service, 1995, the allotment exhibits 6,969 acres of land suitable for cattle grazing and is divided into five separate pastures or units to facilitate a rest rotation grazing system that is designed to coordinate livestock grazing with wintering big game species. The five pastures are: 1) Upper Joe's Valley, 2) North Trail East, 3) North Trail West, 4) Trail Canyon, and 5) South Trail. The last two pastures are important big game wintering areas and in the past a portion of the South Trail unit has been closed to livestock grazing to improve Elk winter range (see Plate 4-3).

Allowable grazing season is from June 21 to September 20, annually. Approximately 793 AUM's are contributed by the Trail Canyon pasture and 595 are attributable to the South Trail pasture. Based on an overall average without regard to proximity to water or physical barriers, the average existing use in the Trail Mountain Allotment is approximately 0.13 AUMs per acre or 7.7 acres per AUM (Healy, 1998). The cattle are owned by separate livestock operators. Excepting "rested" pastures, cattle enter the allotment by Trail Canyon and then leave via Cottonwood Canyon from the northern units. Plate 4-3 indicates that range fences, water troughs, stock tanks (ponds),

and cattle guards overlie the allotment area.

History of Mining - Mining activities existed on or near the site of the Trail Mountain Mine since 1898 (Doelling, 1972). The first large scale operation on the site, the Johnson Mines, opened in 1909. A series of three mines, the Johnson property operated from 1909 through 1948. The amount of coal produced during that period and the extent of the workings is unknown.

In 1946 three additional operations started in Cottonwood Canyon. Two prospects operated for a short time (1946-1952) (Doelling, 1972). Activity at the Trail Mountain Mine started in 1946 and lasted until 1967. The mine was then shut down for 10 years and reopened under the ownership for Mr. John Bell of Orangeville, Utah. Mr. Bell operated the mine until 1979. The Fetterolf Group then operated the mine until 1981, when it was purchased by Natomas Trail Mountain Coal Company. The property was subsequently purchased by Diamond Shamrock, later by Arch Minerals Corp., by Beaver Creek Coal Company (1987), and by PacifiCorp (1992).

### 411.130 Land Use and Classifications under Local Law

The current land uses of the permit and adjacent area fall under two Emery County zoning regulations. One is (MR & R-1 Zone) Mining Grazing and Recreation and the second is (M-1) Mountain Zone. The Mountain Zone allows mining activity, which is a major part of the County's economy, as a conditional use with careful planning and permitting. The mine site is in the M-1 zone.

### 411.140 Cultural and Historic Resources Information

The Mine site contains no known cultural resources that are liable to be impacted by the continued operation or compliance construction.

The area has had numerous cultural resource surveys and inventories. No cultural resources have been found around the mine facilities. Additional surface construction or disturbances related to mining operations will be surveyed (cultural) as required.
No historical resources are known to exist within the mine plan area. A study performed by Archeological Environmental Research Corporation (AERC) in July 1979 showed no historic sites in the canyon bottom (see Plate 5-1 and Appendices 1 & 2, in Confidential Volume).

Archeological Inventory (Adjacent Area) - Five archeological sites (279E/1 through 279E/5) and four isolated artifacts (279E/x1 through 279E/x4) were identified by AERC in the lower section of Cottonwood Canyon (see Plate 5-1: Refer to PacifiCorp Confidential and Private Information Volume: Trail Mountain tab). Two of the archeological sites, 279E/3 and 279E/5 have important data remains. Some vandalism had occurred at these sites. "The abundance of charcoal and the lack of ceramics", suggests possible datable archaic habitation. Site depths of up to a meter of fill evidently contain important stratigraphic data. Both sites have register potential (CRRS: S-2) because of the scientific information potential". (AERC, 1979.)

Site 279E/2, located north of 279E/4 is something of an enigma. The site consists of a rectangular stone foundation, but the lack of other surface materials, and apparent depth, make it difficult to determine whether the site was historic or an unusual, perhaps an uncompleted prehistoric structure. Because of the stone alignments, and its pinon-juniper bench location, the site is suspected as prehistoric. It was judged not to have National Register potential and rated CRRS: S-4.

The two remaining sites 279E/1 and 2 were both CRRS: S-4 lithic scatters. No diagnostic tools were found upon them or any of the other previously described sites (for a complete discussion related to the cultural resources of Cottonwood Canyon refer to AA Preliminary Report on the Cultural Resources and Test Excavations in Cottonwood Canyon, Emery County, Utah [UP&L-79-5A, B, C]@, 1979, report prepared for Utah Power & Light Company by Archeological Environmental Research Corporation, Salt Lake City, Utah).

Two of the isolated artifact locations 279E/X1 and X2 had every appearance of having been sites long since eroded. These isolates compliment the two other lithic scatters and indicate limited hunting activities along the drainage. The depth of charcoal in the rock shelters indicates that their prehistoric occupation could involve a considerable chronological period.

In the area the artifacts were located, little impacts from the mining activities will occur. The sites located near the roadside will be and have been subject to vandalism. Future improvements to the road suggested by Emery County and the Forest Service may significantly impact the sites.

Paleontologic Inventory - Fossils are found on the mine plan area in nearly all of the geologic units. With the exception of dinosaur footprints found in the coal seams of the Blackhawk Formation, no significant paleontologic specimens are known to be present (US Forest Service, 1978).

The cultural resource maps in Appendix 4-1 shows the cultural or historic resources within the permit and adjacent areas.

Parks, Cemeteries, Trails -There are no public parks within the permit or adjacent area. There are no cemeteries located in or within 100 feet of the proposed permit area. There are no lands within the permit area which are within the boundaries of any units of the National System of Trails or the Wild and Scenic Rivers System, including rivers designated under section 5(a) of the Wild and Scenic Rivers Act.

SHPO Coordination – When cultural resources are identified on lands belonging to the USFS, State of Utah and/or the BLM which lie within the permitted areas, SHPO will be contacted.

Prevent Adverse Impacts - Measures used to mitigate the effects of the mining operation on

cultural resources were implemented prior to any disturbance associated with the development.

During 1985 and 1986, the proposed construction and realignment of three miles of county road by Emery County from Highway 29 to the Mine site was completed. Two cultural sites were located and avoided during the road construction. Once construction began, avoidance procedures were the feasible mitigation measures.

Manmade and natural stock ponds are provided on the Trail Mountain area as a source of water for grazing cattle. These ponds are supplied by snow runoff or springs. There are several developed springs in the allotment areas that have watering troughs. If subsidence affects ponds, the ponds will be rebuilt or repaired. Should subsidence alter a seep or spring that is supplying a water source to livestock, the permittee will, after consulting with the Forest Service and DOGM, commit to replace or relocate the trough or pond to a suitable range area. The permittee has implemented a subsidence and hydrologic monitoring program whereby, the extent and the effects of subsidence to water resources can be studied, identified, and the appropriate mitigating action taken.

Identify and Evaluate- If required by the Division, the applicant will identify and evaluate important historic and archeological resources that may be eligible for listing on the National Register of Historic Places through; collection of additional information; conducting field investigations; or other appropriate analyses.

### 411.200 Previous Mining Activity

Underground Mined Areas - The Johnson mines, located across the canyon from the Mine facilities were active from 1909 to 1948. The Cottonwood Canyon prospects are located across Cottonwood Canyon from the Mine. The Cottonwood Canyon prospects were active from 1946 to 1948. No other known minerals of value have been mined within the permit or adjacent area.

Production from the earlier mines was from the Hiawatha seam by room and pillar mining. An

estimated production of 96,000 tons is reported by Doelling (1972) for all mining in the area. Of this, the Cottonwood Canyon mines produced approximately 54,000 tons.

Surface Mined Areas - There have been no surface mines located within the mine permit or adjacent areas.

## 412 Reclamation Plan

### 412.100 Postmining Land Use

Postmining land use within the permit and adjacent area following reclamation will remain essentially the same as the regional uses. See Plate 4-2. Regional multiple uses are a combination of coal mining, grazing, wildlife habitat, hunting and recreation. The Applicant is not proposing a post-mining land use that differs from the pre-mining land use. The post-mining land and the pre-mining land use differ only because there were pre-law (DOGM 1976) activities on the mine site.

Use of the reclaimed site will probably be recreational during late spring, summer, and fall and for wildlife grazing during the winter and early spring. In this area, the recreational use should not interfere with the wildlife use due to limited access during the winter months.

Return of the mine site to the pre-mining land-use of grazing, wildlife, and recreation at the end of mining will be accomplished according to the steps provided in this permit. Refer to Sections 242, 340, 540 for additional information. Contemporaneous reclamation of those areas not needed during operation will take place throughout the life of the mine.

Postmining Land Use Management Plans - Management of range and grazing activities within the permit area will be the responsibility of the US Forest Service, State of Utah and for the waste rock storage area the Bureau of Land Management. The Applicant intends that the

postmining land uses will be consistent with the land use plans prepared by the surface management agencies. Final reclamation activities such as grading and seeding as detailed within this M&RP will be completed in a manner to provide uses of the lands consistent with the land owners.

### 412.200 Land Owner or Surface Manager Comments

Surface owner approval of the Applicant's proposed postmining land use will be confirmed by the approval of this Mining and Reclamation Plan.

### 412.300 Suitability and Capability

Final fills will not contain excess spoils.

## 413 Performance Standards

### 413.100 Post Mining Land Use

Reclamation will be performed in a timely manner. The land after reclamation will be capable of supporting the proposed postmining land use.

### 413.200 Determining Pre-mining Uses of Land

The pre-mining land use included grazing, wildlife habitat, recreation, and industrial (prelaw mining). Refer to Section 411.100 for additional information.

### 413.300 Criteria for Alternative Post-mining Land Uses

An alternative post-mining land use is not proposed.

## 420 Air Quality

This section includes descriptions of plans to comply with the Clean Air Act and applicable Utah or federal statutes and regulations pertaining to air quality standards.

On July 9, 2016, an application for Air Quality Small Source Exemption Registration for Fossil Rock Mine facilities was sent to the Utah Division of Air Quality (DAQ). The registration was granted September 7, 2016 by the DAQ. The exemption registration application, calculations and registration are available for review at the DAQ office in Salt Lake City, Utah.

### 421 Air Quality Standards

Mining activities will be conducted in compliance with the requirements of the Clean Air Act and the Utah Air Quality Regulations.

### 422 Compliance Efforts

Several practices are incorporated in the operations of the mine to protect the air quality in the mine vicinity. Protection of the air quality is mainly accomplished by reduction of dust production by the mine operations. Practices used to reduce dust production are:

a) Periodic watering, scraping, and compaction of coal loading area, and paving of the coal haulage road.
b) Wetting of coal during handling activities.
c) Keeping the size of the disturbed area to a minimum.
d) Revegetation of disturbed areas as soon as practical.

The effect on air quality by the mine will be minimal due to the limited area and the mitigation measures incorporated in the operation.

### 423 Air Pollution Control Plan

Monitoring Programs - The DAQ does not require an air monitoring program for the mine.

Fugitive Dust Control Practices - Emissions from the exposed areas shall be minimized through the operating practice of suppressing dust and revegetation. Additional information in Section 422.

### References

Niebergall, John-US Forest Service, District Ranger, Manti-LaSal National Forest, Ferron, Utah - Range Improvement and Allotment Description.

US Forest Service, 1978. Environmental Assessment – Trail Mountain Federal Lease U-982996. Price, Utah.

US Forest Service, 1979. Land Management Plan. Ferron-Price Planning Unit, Manti-LaSal National Forest, Price, Utah.

US Forest Service, 1982. Environmental Assessment – Trail Mountain Coal Company, Tract 2 Coal Lease U-49332. Price, Utah.

Plateau Mining Company, 1980. Cultural Resources. Report prepared by Archeological - Environmental Research Corporation for Plateau Mining Company, Wattis, Utah.

Utah Power & Light, 1980. Mining and Reclamation Plan, Wilberg Mine-Cottonwood Modification. Salt Lake City, Utah.

A Preliminary Report on the Cultural Resources and Test Excavations in Cottonwood Canyon, Emery County, Utah (UP&L-79-5A, B, C)@ , 1979, report prepared for Utah Power & Light Company by Archeological Environmental Research Corporation, Salt Lake City, Utah.

# APPENDIX 4-3

# PRIME FARMLAND

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 4-3

## PRIME FARMLAND DETERMINATION

United States
Department of
Agriculture

Soil
Conservation
Service

P. O. Box 11350
Salt Lake City, UT 84147

February 4, 1986

Allen P. Childs
Chief Engineer
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537-0370

Dear Mr. Childs:

We have completed our review of the data furnished by Keith Beardall, District Conservationist, Soil Conservation Service, Price, Utah concerning the area of your request January 14, 1986.

According to his investigation report and information in this office, soils located in T. 17 S., R. 6 E., Sec. 25, Sec. 26 and Sec. 35 do not qualify as Important Farmlands because soil temperatures are too cold or slopes are too steep.

If we can be of further assistance, please call on us.

Sincerely,

Ferris Allgood

FERRIS P. ALLGOOD
State Soil Scientist

cc: Keith Beardall, DC, SCS, Price, UT

The Soil Conservation Service
is an agency of the
United States Department of Agriculture

50

* U.S. Government Printing Office: 1983—420-838/1578

United States Department of Agriculture
Soil Conservation Service
350 North 4th East
Price, Utah 84501

November 3, 1983

Allen Childs
Natomas Trail Mountain Coal Company
P. O. Box 370
Orangeville, Utah 84537

Dear Allen:

The riparian area along the streambank where the willows and narrowleaf cottonwood grows is about 2,500 lbs. per acre production. The site is in fair condition.

The Salina wildrye site on the steep side hill is producing about 900-1,000 lbs. per acre. The condition of this site is good.

George S Cook

George S. Cook
Range Conservationist
Price, Utah

United States
Department of
Agriculture

Soil
Conservation
Service

P. O. Box 11350
Salt Lake City, UT 84147

May 26, 1983

Jim Schlenvogt
Trail Mountain Mining
Natomas Coal Company
P. O. Box 370
Orangeville, UT 84537

Dear Mr. Schlenvogt:

Keith Beardall, District Conservationist, had a review made of the site located in Cottonwood Canyon Area. On the basis of his report, the soils in this area do not meet the requirements for prime farmland because no irrigation water is available and the area is too steep.

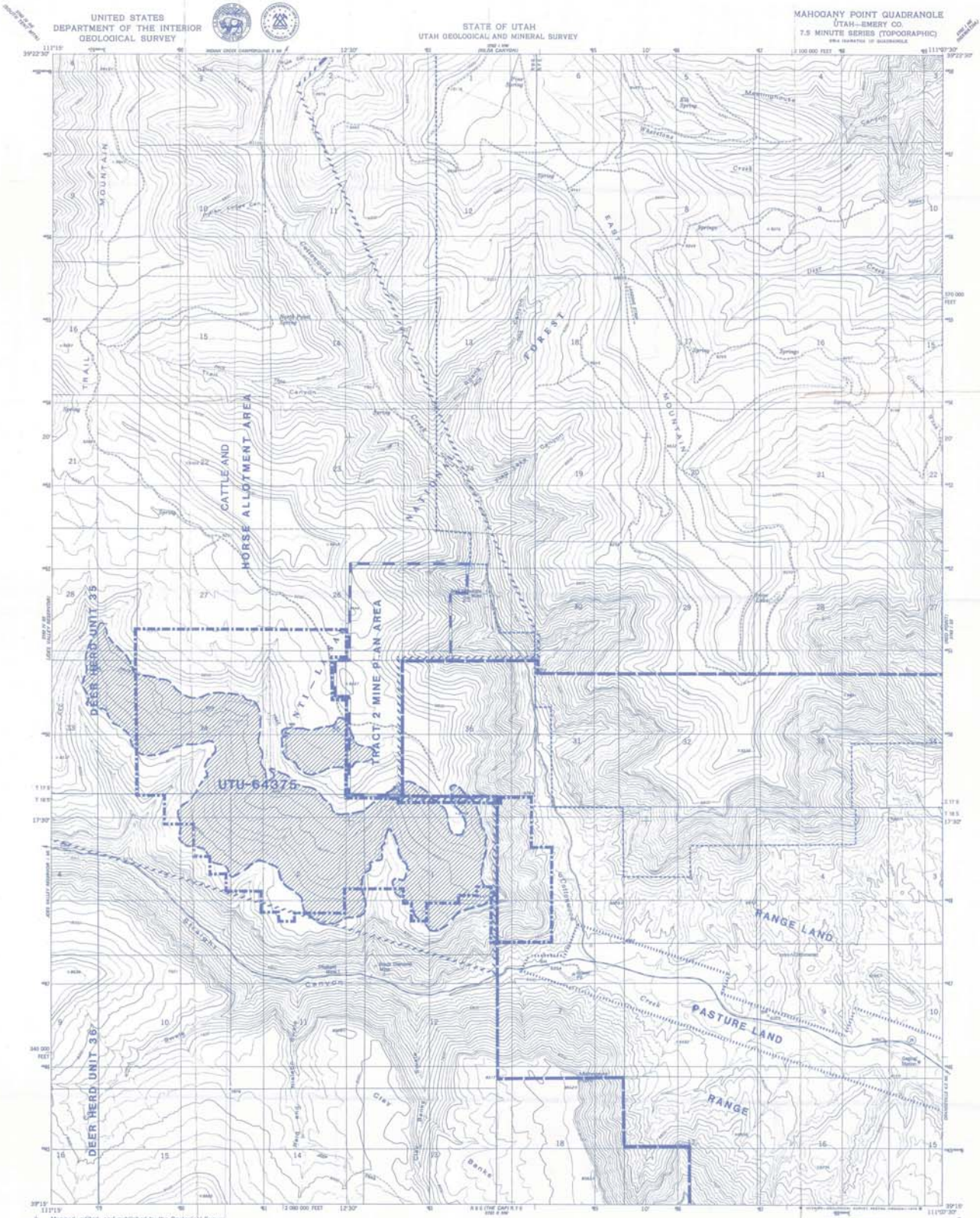
If we can be of further assistance, please let us know.

Sincerely,

Francis T. Holt

FRANCIS T. HOLT
State Conservationist

cc: Keith Beardall, DC, SCS, Price, UT


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
STATE OF UTAH
UTAH GEOLOGICAL AND MINERAL SURVEY
MAHOGANY POINT QUADRANGLE
UTAH—EMERY CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
TRAIL MOUNTAIN
CATTLE AND HORSE ALLOTMENT AREA
FOREST
DEER HERD UNIT 35
DEER HERD UNIT 36
UTU-64375
TRACT 2 MINE PLAN AREA
RANGE LAND
PASTURE LAND
RANGE
Mapped, edited, and published by the Geological Survey
SCALE 1:24 000
CONTOUR INTERVAL 80 FEET
DOTTED LINES REPRESENT 40-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
ROAD CLASSIFICATION
MAHOGANY POINT, UTAH
1979
FOREST BOUNDARY
UP&L PERMIT BOUNDARY
ALLOTMENT BOUNDARY
Permit Application Area
Watershed Improvement Area
(Contour Furrows)
Trail Mountain No. 9 Mine
LAND USE MAP
REVISION
DATE
BY
GEOLOGY BY
ENGINEERING BY
SURVEYED BY
5/90
K.S.F.
PREPARED BY A.P.C. D.W.G. K.S.F.
APPROVED BY
SCALE
SHEET ____ OF ____
DWG. NO. TMS1458D
FIGURE 4-3

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# ENGINEERING

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Yellow highlight signifies Text/Information Previously in Approved DOGM Permit, Moved and incorporated into Chapter 5 from previous Chapters 3 and 11). Red text within the yellow highlight is revised text. The un-highlighted text is new information being added to the permit document.

# Chapter 5
# ENGINEERING

## 510 Introduction

The existing and proposed coal mining and reclamation activities associated with the mine have been or will be designed, located, constructed, maintained, and reclaimed in accordance with the permit commitments.

The Division was notified of temporary cessation of coal mining operations at the Trail Mountain Mine effective May 4, 2001. Coal mining at the Trail Mountain Mine ceased as of March 15, 2001. In preparation of temporary cessation, all mining equipment including; production (longwall and continuous miner), belt haulage and electrical were removed from the mine. Verification of equipment removal was conducted on April 6, 2001 with Bureau of Land Management (Steve Falk) and Division of Oil, Gas and Mining (Pete Hess) participating in the review. A plan to construct permanent seals was submitted to and approved by Mine Safety Health Administration. Sealing of the mine portals was completed on May 1, 2001.

The Fossil Rock Mine is not currently operating. The Mine (previously named Trail Mountain) moved into temporary cessation in 2001 and moved out June 2016 and back into temporary cessation in October 2018. There is the potential for the Applicant to re-open the mine and begin development mining in 2020. Fossil Rock has leased the Cottonwood Tract Lease, although this lease will not be mined until permitted a variety of baseline information associated with the lease is provided in this chapter.

## 511 General Requirements

This permit application includes descriptions of the proposed coal mining and reclamation operations together with the appropriate maps, plans, and cross sections. Methods and calculations utilized to achieve compliance with the design criteria are also presented.

## 512 Certification

Where required by the regulations, cross sections and maps in this permit application have been prepared by or under the direction of, and certified by, qualified registered professional engineers, geologist or land surveyors. As appropriate, these persons were assisted by experts in the fields of hydrology, geology, biology, etc.

### 512.100 Cross Sections and Maps

Previously mined areas are shown on Plate 5-1. Access to the coal seam is facilitated by the intersection at the mine site of the coal outcrop and the canyon floor.

Certified maps and cross sections concerning the disposal of underground development waste at the waste rock site are provided in this M&RP as a separate volume. Coal storage, topsoil storage and explosive storage are shown on Plate 5-2.

Certified maps and cross sections showing the final (post-reclamation) surface configuration of the mine disturbed area is shown on Plates 5-12, 5-13, 5-14A and 5-14B.

Maps and cross sections associated with the hydrology of the Mine area are provided on Plate 7-1, 7-2 and 6-1. Maps and cross sections associated with the geology of the Mine area are provided on Plates 6-1 and 6-2.

## 512.200 Plans and Engineering Designs

Plans and engineering designs presented in this M&RP were prepared by or under the direction of and certified by a qualified registered professional engineer. The following facilities or activities do not exist or occur within the permit area: coal preparation plant, coal cleaning, coal processing waste banks, dams, or embankments, disposal of non-coal (non-waste rock) waste other than durable rock-type construction materials such as cinder block and air pollution control facilities. Hence, certified maps or cross sections of these facilities are not provided in this plan.

No excess spoil will be generated from the permit area. No durable rock fills will exist in the permit area. The durable rock-type construction materials are disposed of in the waste-rock storage site together with the mine development waste. The design of the waste-rock facility located in a separate volume has been certified by a qualified registered professional engineer.

Impoundments - At the waste rock storage site, there is one sediment pond and one sediment basin shown on Plate 4-1 in the waste rock site volume of this M&RP. The mine facilities area has one existing sediment pond shown on Plates 5-2 and 5-8. These impoundments were designed by a professional engineer using current, prudent, engineering practices and the designs were certified by a qualified registered professional engineer.

Primary Roads - A primary access road is used to haul material into the Waste Rock Storage Facility (Plate 4-1). A professional engineer has certified the design and construction of the road as meeting the requirements of R645-301-534.200 and R645-301-742.420.

The primary and ancillary roads at the mine site are shown on Plate 5-2. The primary road is shown in plan and profile on Plate 5-16.

Variance from Approximate Original Contour - The design for the proposed variance from the approximate original contour requirements of R645-301-270 has been certified by a professional engineer in conformance with professional standards established to assure the stability,

drainage, and configuration necessary for the intended postmining use of the site. Refer to Sections 537 and 553 for additional information.

## 513. Compliance with MSHA Regulations and MSHA Approvals

### 513.100 Coal Processing Waste Dams and Embankments

No coal processing waste dams or embankments exist within the permit area.

### 513.200 Impoundments and Sedimentation Ponds

No impoundments or sedimentation ponds in the permit area meet the size criteria of 30 CFR 77.216-1 or 30 CFR 77.216-2.

### 513.300 Underground Development Waste, Coal Processing Waste

No underground development waste, coal processing waste, or excess spoil is disposed of in underground mine workings in the permit area.

### 513.400 Refuse Piles

The waste-rock disposal area has been designed and constructed to meet the requirements of 30 CFR 77.214 and 30 CFR 77.215. Details of this design are presented in the waste rock area M&RP volume.

### 513.500 Underground Openings to the Surface

Upon abandonment, openings to the surface from the underground will be managed in accordance with 30 CFR 751771. Details regarding final abandonment of mine openings are provided in Section 542.700.

### 513.600 Discharges to Underground Mines

No discharges occur from the surface to underground mine workings in the permit area.

### 513.700 Surface Coal Mining and Reclamation Activities

No surface coal mining and reclamation activities exist within the permit area.

### 513.800 Coal Mine Waste Fires

If coal mine waste fires occur within the permit area, remedial action will be taken as deemed necessary by the Applicant to protect public health and safety as well as the environment. Following initial remedial efforts, a plan will be formulated in discussion with MSHA and the UDOGM to prevent future fires and to extinguish fires.

## 514 Inspections

### 514.100 Excess Spoil

Excess spoil is not generated at the Mine.

### 514.200 Refuse Piles

A professional engineer or specialist experienced in the construction of similar earth and waste structures will inspect the refuse pile during construction and placement/compaction of the coal mine refuse materials.

These inspections will occur at least quarterly throughout placement of the waste materials and during the following critical periods of the phased construction of the site:

- Foundation preparation (including removal of organic material and topsoil),
- Placement of underdrains and protective filter systems,
- Installation of final surface drainage systems, and
- The final graded and revegetated fill.

An inspection report will be submitted to the Division that is certified by a registered professional engineer. The report will discuss construction, stability and maintenance in accordance with the approved plan and the R645 rules. A copy of the inspection report will be retained by the

Permittee. Inspections will continue until the waste-rock area has been finally graded and revegetated.

### 514.300 Impoundments

A professional engineer or specialist experienced in the construction of impoundments will inspect the impoundment(s). Inspections will be made regularly during construction, upon completion of construction, and at least annually until removal of the structure or release of the performance bond. A qualified person designated by the Applicant shall examine impoundments for the appearance of structural weakness and other hazardous conditions.

A certified report that the impoundment has been constructed and maintained as designed and in accordance with the approved plan and the R645 Rules will be submitted to the Division. A copy of the report will be retained by the Permittee.

Impoundments located in the permit area do not meet the NRCS Class B or C Criteria for dams in TR-60 and are not subject to 30 CFR Sec. 77.216.

## 515 Reporting Emergency Procedures

### 515.100 Slides

At any time, a slide occurs which may have a potential adverse effect on public, property, health, safety, or the environment, the Applicant will notify the Division by the fastest available means and comply with any remedial measures required by the Division.

### 515.200 Impoundment Hazards

If an impoundment examination or inspection discloses that a potential hazard exists, the Division will be informed of the finding and of the emergency procedures formulated for public protection and remedial action. The Division will then notify the appropriate agencies that other emergency procedures are required to protect the public.

### 515.300 Temporary Cessation of Operations

Whenever it is known that operations are to be temporarily ceased for more than 30 days, the Applicant shall submit to the Division a notice of intention to cease or abandon the operations, in accordance with R645-301-515320 and to MSHA standards.

The Applicant will provide a statement of the number of surface acres and the horizontal and vertical extent of subsurface strata which have been in the permit area prior to cessation or abandonment, the extent and kind of reclamation of surface area which have been accomplished and identify activities that will continue during the temporary cessation.

If underground openings are to remain inactive for a period greater than 90 days, such openings will be temporarily closed off from access.

## 520 Operation Plan

### 521 General

#### 521.100 Cross Sections and Maps

Plate 5-1 shows the location and extent of known workings of active, inactive, or abandoned underground workings, including openings to the surface, within the permit and adjacent areas.

The buildings and structures, impoundments and drainage structures associated with the Mine are shown on Plate 5-2. There are no major electric transmission lines, pipelines, or agricultural drainage tile fields that pass through or over the permit area. The Applicant is supplied electrical power via an overhead power line that ends at the mine site.

The Cottonwood Canyon Road is located immediately east of the permit boundary. The permit boundary for the waste rock storage site adjoins State Road 57. Even though Permittee owns land that extends to the centerline of the county road, Permittee decided the permit boundary will permanently reside on the western edge of the county road to avoid the responsibility of any

legal issues or potential environmental violation that may be caused by public use of the county road.

The waste rock storage area and the associated drainage structures are shown and described in waste rock M&RP volume on Plate 4-1. The location of the waste-rock disposal area in relation to the underground mine workings, is discussed in Sections 521, 528, and 536 of this M&RP.

The owners of record of the surface and subsurface lands in or contiguous to the permit area are shown on Plates 5-4 and 5-5.

The Applicant has legal right to enter all lands within the permit area. The legal description of the permit area is provided in Chapter 1, Section 114.

The mining operation is conducted within 100 feet of a public (county owned) road. The requirements of R645-103-234 and protection of the public interests are met in the following ways:

(1) This is a pre-law operation, and has always been located adjacent to the public road which provides access to the public and private lands in and beyond Cottonwood Canyon;

(2) The road has been upgraded and paved through cooperation of the Mine, Emery County Road Department, and the US Forest Service;

(3) Necessary approvals for the road have been obtained from the authorities with jurisdiction over the public road through the cooperative effort of upgrading and paving of the road to the mine site. Necessary encroachment permits have been obtained from Emery County for accesses to and from the public road.

(4) Required public notices concerning the operation have been posted in local newspapers for Permit Approvals, Permit Renewals and Permit Transfers.

Historically, first and second mining occurred in the areas within the southern end of Trail Mountain. Those areas have been mined out and the leases have been relinquished to the federal agencies for those areas.

Refer to Section 525 for information pertaining to subsidence.

Surface configurations are shown on Plate 5-4. Building, utility corridors, facilities, coal loading and storage are shown on Plate 5-2 Surface Facilities. The land affected by the underground mine workings and sequence of mining are shown on Plate 5-3. Topsoil stockpiles are shown on Plate 5-2. The land affected by the waste rock site is shown on Plate 4-1 in separate M&RP volume.

A performance bond is provided for the surface disturbance and facilities as shown on Plates 5-2 and 4-1 in separate M&RP volume for the waste rock site.

Access to the mine is provided by county road, Forest Service road, and private right-of-way along Cottonwood Creek. The road is paved and used by mine personnel private vehicles, coal trucks for haulage, and by the public for access to the upper canyon. Roads constructed, used, or maintained by the Mine in the permit area for the mining and reclamation operations are shown on Plate 5-2. No rail systems or overland conveyor systems (other than the material-handling conveyors within the mine yard) are associated with the mining operation. Mine yard conveyors are listed in Section 527.200. Drainage structures associated with the roads are explained in Section 530 of this chapter. Cross sections of the roads are provided on Plate 5-16.

### 521.200 Signs and Markers

Signs and markers will be posted, maintained, and removed by the Permittee, be a uniform design that can be easily seen and read, made of durable material, conform to local laws and regulations and maintained during the activities to which they pertain.

Mine and permit identification signs are posted along the access to the mine property and at the northern and southern property boundaries. Perimeter markers (disturbed area boundary) have been installed. Stream buffer zone signs are maintained on the west side of Cottonwood Creek. Permit ID signs and required perimeter markers will be maintained until bond release.

A topsoil stockpile sign will be placed to mark where topsoil or other vegetation-supporting material is physically segregated and stockpiled. A topsoil stockpile sign is installed on the existing small topsoil stockpile.

88888

### 522 Coal Recovery

The maximum amount of economically recoverable coal will be extracted with the exception of protective coal, which must be left in place to ensure the integrity of the mine. This protective coal falls into two categories. The two categories are barrier coal and strata control coal.

Mining plans and projections may change between permit submittal and actual mining. However, the Applicant will commit to conducting operations in accordance with accepted industry practices, so as to achieve maximum economic recovery as specified by 43 CFR 3482.1 (c) (7). The Applicant commits to professional cooperation with the Bureau of Land Management (BLM) in achieving MER on Federal coal leases.

**TABLE 5-1**
**RECOVERABLE RESERVES**

| LEASE AREA | IN-PLACE TONS | RECOVERABLE TONS | ACTUAL PRODUCED TONS By EWMC (as of 6/1/2001) | TOTAL PRODUCED TONS BY ALL |
|---|---|---|---|---|
| *Federal Lease UTU-49332 | 4,361,837 | 1,239,936 | 22,917 | 1,509,199 |
| Federal Lease U-082996 | 276,954 | 56,718 | 0 | 219,755 |

| | | | | |
|---|---|---|---|---|
| **Federal Lease U-64375 | 45,404,832 | 433,363 | 21,508,007 | 21,938,730 |
| TOTAL TONS | 50,043,623 | 1,730,017 | 21,530,924 | 23,667,684 |
| TOTAL REMAINING TONS | | 1,730,017 | | |

*Partial relinquishment of 261.47 acres effective January 9, 2009.
**Partial relinquishment of 2504.01 acres effective January 9, 2009.

**523 Mining Methods**

Continuous Mining Unit - Longwall retreat mining with continuous miner development of mains, longwall panels and gate road development will be employed during the life of the mine.

The principal purpose of continuous mining units used in longwall retreat mining applications include: section development of mainline entries, longwall sections - gate road development and longwall section - setup/bleeder entry development.

Figure 5-4 illustrates the basic configuration of a typical five entry main, consisting of 20 ft. wide entries and crosscuts driven on 80 ft. x 100 ft. pillar centers. The pillars created measure a nominal 60 ft. wide x 80 ft. long. The actual number of entries used may be more or less and is based on ventilation requirements. The actual pillar sizes used will depend on their adequacy to support the overlying strata.

Figure 5-4 also illustrates the basic configuration of a typical two-entry longwall panel development, consisting of 20 ft. wide entries and crosscuts driven on 50 ft. x 100 ft. pillar centers. Bleeder and setup development consist of 20 ft. wide entries and crosscuts on nominal 50 ft. x 100 ft. pillar centers. With the retreating longwall mining system, all panel development work is accomplished by continuous mining units prior to longwall equipment installation.

Longwall Mining System - The predominant mining method at the Mine will be longwall retreat mining. Figure 5-5 illustrates the basic configuration of a retreating longwall system. After gate road entries are driven to the extent of the longwall panel length, on both sides of the longwall face, setup and bleeder entries are driven to connect the gate roads. A solid coal barrier is left between the setup and bleeder entries, sized based on geologic parameters, to insure long term bleeder stability.

Longwall face width, depending on geologic parameters of the coal deposit, varies from 500 ft. to 1000 ft. wide. Standard face width is 1,000 ft., from center-line of headgate entry to center-line setup entry, the longwall begins retreat mining; from the setup entry, "outby" toward the mainline entries. A protection barrier is left between the mined-out longwall panel (extraction face) and the mainline entries; sized to insure long term mainline entry stability. Panels are designed within the mining area, bounded by natural and imposed limits with varying degrees of confidence as to location and extent. Lease boundaries are definitely located and invariable in the short term. Faults may vary somewhat from currently assumed locations. Geologic limitations; such as seam splits, faults, channel scours, spars, stratigraphic thinning, etc. may affect the mining limits by varying hundreds of feet as information becomes available and as mining recovery economics and practicality are further refined. Underground burned areas, from a practical point of view, are indeterminate prior to mining. Regulatory mining restrictions, such as escarpment protection barriers and perennial stream buffer zones further confine the mining extent.

Within the limitation of the above boundaries, longwall panel length and width are maximized to the extent possible due to the economic cost and production loss associated with longwall moves. The minimum panel length, currently considered economical, is 1500 ft. of recoverable reserves. The minimum panel width, currently considered economical, is 500 ft. of recoverable reserve.

The plan of mine development projected for the Mine is shown in Plate 5-3. Maximum production will be 5,000,000 tons per year.

Major Equipment - The listed major type of equipment or equivalent is expected to be used in the future.

| | |
|---|---|
| Continuous Miners | Shuttle Cars |
| Section Scoops | Roof Bolters |
| Feeder Breakers | Rock Dusters |
| Longwall Shearer | Mantrips |
| Face Conveyor | Compressors |
| Longwall Shields | Coal Drills |
| Stage-loader | Mobile Tailpiece |
| Crusher | Scoop/Forklift |
| Conveyors | |

No surface coal mining and/or reclamation activities are proposed.

### 524 Blasting and Explosives

Explosives will potentially be returned to the site in the future and at that time the following storage and use sections will apply.

Explosives and caps are stored in separate MSHA approved explosive magazines. The magazines are of approved steel construction and are properly electrically grounded. The magazines are located as required to provide added security. Materials are transported in approved boxes. Explosives are primarily used underground.

When surface blasting is done it will be in accordance with the applicable R645- 301-524 rules. Surface blasting will be done by a certified blaster under the Utah Blaster Certification Program. Underground blasting activities at the Mine are conducted under the direction of a MSHA certified blaster.

Design - Blast designs will be prepared by a certified blaster in accordance with the applicable rules and regulations. No blasts will utilize more than five (5) pounds of blasting agent or

explosives detonated in any eight-millisecond period; therefore, a pre-blast survey is not required. Blasting records will be kept on file for review for three years. Signs will be placed at accessible entrances to the surface blasting area from public roads. Access control will be exercised preventing unauthorized access to the blasting area.

## 525 Subsidence

### 525.100 Subsidence Control Plan

Pre-subsidence Survey- Plates 4-3, 7-1 and 7-4 show the location and type of structures and renewable resource lands that subsidence may materially damage or for which the value or reasonably foreseeable use may be diminished.

Survey - A survey has been conducted on that portion of the surface which could possibly be affected by the mining activities. It has been determined that there are renewable resources present in the area in the form of springs, water seeps, grazing land, timber, and wildlife. The water seeps and springs are limited and are an important resource for grazing and wildlife. The streams within the permit area are ephemeral and/or intermittent. The streams are fed by springs that emanate primarily in the North Horn formation. Some of the springs feed water troughs maintained for livestock and wildlife. The occurrence of the springs is discussed in the Chapter 7 hydrology section; however, data collected suggest the springs on the surface will not be affected by the subsidence.

No cabins or occupied non-commercial buildings or occupied residential dwellings or man-made structures are present within the permit area except for the buildings constructed to support of the mining operation. Subsidence in the area of these buildings is not anticipated.

There are four gas wells within the northeast portion as shown on Plates 4-1 and 4-2. A gas pipeline parallels the permit boundary to the northeast. The gas pipeline does not cross through the facilities area. There is no mining planned beneath the gas pipeline or around the gas wells. No water wells are located within the permit area, nor are there any power transmission lines other than the one in Cottonwood Canyon which supplies power to the mine. Subsidence should not impact these structures.

### 525.200 Protected Areas

There are no public buildings and facilities, churches, schools, or hospitals within the permit and adjacent areas. There are no impoundments with a storage capacity of 20 acre-feet or more or bodies of water with a volume of 20 acre-feet or more within the permit and adjacent area. Thus, no subsidence protection zones are necessary for these features.

Plate 5-3 shows a detailed plan of the underground workings.

The Applicant will use a mining technology that provides for planned subsidence in a predictable and controlled manner. Barrier pillars were left by Pacificorp around oil and gas wells, surface structures and streams, property boundaries and outcrops.

### 525.300 Subsidence Control

Plate 5-3 depicts the area in which planned subsidence mining methods will be used.

### 525.400 Subsidence Control Plan Contents

Conditions - Overburden within the proposed lease area ranges from approximately 750 feet, to more than 2,500 feet. The overburden is lowest along Cottonwood Canyon. The Hiawatha Seam ranges from 5 to 14 feet of minable coal height over the permit area.

Subsidence data collected on East Mountain indicate the most important factors that influence subsidence listed in order of their importance are; 1) width of the area undermined; 2) total thickness of coal extracted; and 3) the overburden thickness. Areas where only one longwall panel (<600 feet in width) has been extracted have shown little or no subsidence. Whereas areas where two adjacent longwall panels (total width >1,500 feet) have been mined subsidence is about 70 to 80% of the seam extraction height. The British National Coal Board (NCB) developed a method for predicting subsidence that has been widely accepted in the United States. This method utilizes graphs compiled from numerous field observations and takes into consideration the length and width of the mined-out area, thickness of coal extracted, and depth of cover. The method is claimed to be correct to +10% in the majority of cases,

assuming certain limiting conditions are met. The amount of total subsidence experienced on East Mountain averages about 83% of the total subsidence predicted by the NCB model.

The angle of draw, which defines the limit between underground excavations and surface effects of subsidence, determines the amount of barrier that must be left around the mine to protect surface features. A recent study over coal mines in Utah and Colorado, undertaken by the USGS, indicates draw angles of $20^0$ in mines with weak to moderately strong overburden 650 to 900 feet thick. This angle tends to steepen to $15^0$ at depths of 900 to 1,000 feet in the Somerset area of Colorado. Data collected by PacifiCorp on East Mountain show draw angles to be steeper, ranging from $3^0$ to $15^0$.

Additional data has been collected regarding East Mountain subsidence using Time Domain Reflectometry technology (TDR). This method shows subsidence reaches the surface almost immediately after mining. This method documents how rapidly caving propagates up the strata by cementing a coaxial cable in a bore hole extending from the surface of the ground down to mine level above a longwall panel. As mining progresses toward and underneath the bore hole, the cable is electronically interrogated which provides data showing the depth at which stress is present and where shearing of the cable propagates up the cable after mining. The data collected on East Mountain in this way showed no change in the cable prior to undermining by the longwall panel but immediately after mining passed below the cable shearing had begun to occur just above the mine level. Shearing propagated to the surface within six days of being undermined.

The subsidence data collected on East Mountain indicates about 90% of total subsidence occurs within the first year after being undermined. The areas undermined generally show no additional subsidence after the second year following the completion of mining.

Most of the subsidence will occur without any visible evidence on the surface. This is because most of the area on Trail Mountain has the North Horn Formation exposed on the surface and this formation contains an abundance of clay minerals that yield to subsidence with plastic deformation and not fracturing. In rare occasions, tension fractures may develop on the

surface along the sides or ends of a group of longwall panels. When undermining areas where the Castlegate sandstone is exposed on the surface, subsidence fractures at the surface will be common. This is because the Castlegate sandstone yields to subsidence through brittle deformation rather than plastic deformation. Future subsidence in the lease area is anticipated to be similar to that which has occurred previously in the area. Subsidence is expected range between 60% an 90% of the seam thickness above longwall panels, with draw angles ranging from 3 to 15 degrees. Previous surveys have indicated that no substantial damage has occurred to vegetation as a result of subsidence within the area.

Mining under the escarpments will be avoided where possible and if necessary will be limited to bleeder entries. The mine plan is designed to minimize the potential for failures of escarpments of the Castlegate sandstone in Cottonwood Canyon and Joes Valley.

Monitoring - The Applicant will annually conduct an aerial photo survey of the areas which have been undermined. The Applicant will install aerial targets over the mine that represents future years of mining. A baseline aerial photogrammetric survey of the area will be performed to establish baseline elevation of the aerial targets.

Annual surveys will be conducted to determine surface deformation due to subsidence and possible movement of surface subsidence monuments for a minimum of two years after no additional subsidence is detected within the area. The findings of the survey shall be reported to the Division annually.

Other than the portals, the Applicant will not back tow or backfill any of the mine openings to prevent subsidence.

The Applicant intends to control subsidence by mining as near complete and uniform extraction as possible. The use of longwall mining provides the most uniform and complete coal extraction possible. This minimizes the potential of tension fractures reaching the surface.

Effects of Subsidence - Several surveys have been conducted over the area presently controlled by various permittees which may be affected by mining operations. Timber, wildlife, grazing areas, water seeps and springs are the renewable resources occurring within the permit and adjacent areas. There are no oil and gas wells, pipelines, utility structures or high powerlines that will be affected by surface subsidence within the lease boundary and adjacent areas. No buildings or dwellings have been constructed on any surface that will be subject to subsidence within the mine plan area. Seeps and springs within the mine permit and adjacent areas have been surveyed and are currently being monitored (refer to Chapter 7 - Hydrology, for a description of groundwater resources and monitoring).

Historic Information - Eighty percent outcrop protection is provided by leaving a minimum barrier of 200' between mine workings and the coal outcrop. One exception to the above is the eastern most entry of the 3-entry system driven north and northeast to the ventilation portal. The eastern entry is located within the 200' barrier for a distance of approximately 240' and at no time comes closer than 160' from the outcrop. The 3-entries were necessary to meet MSHA regulations and provide adequate ventilation. The location of this variance is in the side canyon approximately 1700' south of the forth portal and is shown on Figure A-3-7-2, Appendix 5-7. Outcrop protection is further addressed in the geotechnical chapter of this permit.

The subsidence monitoring at Trail Mountain Mine prior to PacifiCorp's acquisition (November 1992) was conducted using conventional surveying methods. Monitoring did not identify subsidence greater than a few tenths of feet. PacifiCorp used aerial photogrammetric survey methods and annual helicopter reconnaissance flights to monitor subsidence. Baseline photography was conducted August 6, 1993 including color infrared.

### 525.500 Repair of Damage

Although it is possible that subsidence could affect the ground water or surface water, prior experience suggests that it is unlikely. The Applicant will replace water determined to have been lost or adversely affected as a result of the mining operation if such loss or adverse impact occurs prior to final bond release.

During regular monitoring activities required by the permit, or as the Applicant otherwise acquires knowledge, the Applicant will advise the Division of the loss or adverse occurrence to groundwater.

Should significant subsidence impacts occur, the Applicant will restore, to the extent technologically and economically feasible, those surface impacts to a condition capable of supporting reasonably foreseeable uses that such lands were capable of supporting prior to subsidence.

### 525.600 Compliance

The Applicant will comply with the provisions of the approved subsidence control plan.

### 525.700 Public Notice of Proposed Mining

Prior to the beginning of mining, or with the addition of leases, the underground mine operator will mail a notification to the water conservancy district, if any, in which the mine is located and to owners and occupants of surface property and structures above the underground workings. This notification will include identification of specific areas in which mining will occur, dates that specific areas will be undermined, and the location or locations where the Mine's subsidence control plan may be examined.

## 526 Mine Facilities

Mine support facilities will be removed following mining in accordance with the reclamation plan discussed in Section 540.

### 526.100 Mine Structures and Facilities

Surface Building and Structures - The buildings and structures associated with the Mine are shown in Plate 5-2.

The office, shop, sub-station, fan control house, fuel storage tank farm area, and sediment controls were all in place prior to 1987. A new bathhouse, coal handling facility, explosive magazines, ventilation portal, and culinary water system were added in late 1990. The main canyon culvert was also extended approximately 300' at that time. After PacifiCorp purchased the Trail Mountain Mine in 1992, surface modifications have taken place such as, concrete portal liners, new travel portal, new twin fan, new fuel storage area, high pressure water building and tank, relocation of water treatment plant, storage shed, storage dock, modified ROM transfer and a 60" overland tube conveyor. See Appendix 5-4 for the Operation Plan for the structures. Also see Appendices 5-7, 5-8, 5-9, 5-10 and 7-13 for details on the facilities.

Water Supply System - Historically, the culinary water supply for the Mine was drawn from underground mine water. Mine water was collected in an underground sump and skimmed of oil. The mine water is pumped to the surface and stored in a 100,000-gallon tank. Approximately 10,000 gallons per day of this water was prepared in the treatment plant for use as potable water. Some mine water was used for wash down. Water was treated on the surface at a maximum rate of 10 gpm and then stored in two 22,000-gallon capacity fresh water storage tanks. The treatment plant and process are approved by the State of Utah, Department of Environmental Quality, Division of Drinking Water. A schematic of the water system is shown in Figure 5-2. This system was connected to the mine water system at the belt portal location. If the need should develop for filling water trucks or supplying alternate water to the mine or surface system, this water would be drawn from the 22,000-gallon surface storage tanks referred to in Figure 5-2.

Refer to Figure 5-3 for typical underground water system schematic. In preparation of temporary cessation, the mine de-watering system was removed from the mine, except for a six (6) inch steel supply line (8000') and a twelve (12) inch PVC de-watering line (7500'), refer to Plate 5-7 for details. Verification of equipment removal was conducted on April 6, 2001 with Bureau of Land Management (Steve Falk) and Division of Oil, Gas and Mining (Pete Hess) participating in the review.

Longwall shield ( #151) and a face conveyor were left in the mine due to safety concerns.

Pumphouse and Water Tank - A high pressure pumphouse and water tank system was added in 1993. This facility supplied water underground to be used for mining operations.

Substation - The substation is constructed, operated and maintained in compliance with applicable MSHA and electrical codes. The substation was constructed in 1980 and upgraded in 1995. Transformers in the station have been checked and are non-PCB.

PacifiCorp upgraded the power system on August 5, 1995 which consisted of the following: 1) incoming utility power upgraded by Utah Power to 69,000 volts, 60 HZ, phase 3, 2) installation of two (2) identical substation transformers (one of which is a standby/backup unit) rated at 10 MVA. These transformers are located southwest of the office building. The primary voltage is 69,000 volts delta connected, and the secondary will be 12,470 volts wye connected. The existing 7500 KVA transformer will remain in place for a secondary backup power system.

Ventilation Fans -The mine is ventilated by two, 500hp, 70-inch diameter, blowing fans. The fans and the concrete portal liner were installed in the old access portal in 1993 and 1994.

Truck Loadout - The truck loadout is constructed of structural steel and plate and is approximately 30 feet diameter and 70 feet high.

Fences and Gates - Approximately 2,000 feet of chain link fence, containing three multiple access gates, are maintained at the Mine site. The multiple-access gates are made up of 15, 48” X 72” panels (approximate). These panels make up four gates. Some gates have two panels and some have more. The substation is enclosed by a seven-foot chain link fence with a three strand barb-wire cap and two gates. This chain link fence also serves to delineate the east boundaries of the surface disturbance of the mine plan area. Identification and perimeter signs are installed on the fence.

Powder Magazine - The powder magazine was removed from the site in 2001. The magazine may be replaced when the mine opens for operation.

Sewage System - The septic system for the facility was approved by the Division of Water Quality on March 17, 1995. The sewage enters one of three septic tanks, depending on location, removing the majority of solids from the sewage. The grey-water then flows, via an 8-inch line, to the collection/pumping station, located east of the tank farm area. The collection/pumping station contains a 10,000-gallon holding tank and two pumps. In the case of emergencies, the system can dispose of the sewage grey-water at the collection/pumping station by haulage truck to another facility licensed to accept septic tank waste. In 2016 the system is believed to be in place however, the facilities are in poor repair and it can be better determined once the facility begins renovations potentially in 2020. A small pre-engineered metal building houses the collection/pumping station.

Salt Storage - The covered Salt Storage Shed was constructed in1998.

Conveyor Systems **-** The main belt conveyed the coal to the surface, the coal is then conveyed by a belt to the screen and crusher. The screen and crusher facility at the Mine had the capability of sizing the coal. The crushed coal is then conveyed to a bin where it is loaded by a short belt into on-road trucks for shipment. Figure 5-1 shows a generalized schematic of the coal handling systems and Section 528.100 contains additional information. Appendix 5-8 describes further details on the coal handling system.

The facilities area consists of: coal storage areas, parking lot, supply yard, equipment and material storage areas. Controlled pad and parking lot drainage flow across the facility and enters the curb and gutter system which reports to the sediment pond. Other than the 66" diameter culvert beneath the mine site to carry undisturbed drainage from Cottonwood Creek, there is no alteration or relocation of a natural drainageway (Plate 5-15).

Table 5-6 lists the existing structures at the mine, their approximate dates of construction, and their general construction materials. Because the structures were constructed specifically for use as mining facilities, all are considered adequate to meet the requirements of R645-301. No

modifications or reconstruction are required for the structures to meet the requirements of R645-301.

| Table 5-6 Existing Structures | | |
|---|---|---|
| Structure | Construction Date | Construction Materials |
| Office/Warehouse/Shop | 1976 | 2 Story Block |
| Bathhouse | 1990 | Metal Building |
| Substation | 1980 upgraded 1995 | Concrete Footers and Fence |
| Fan Control House | Prior of 1987 | Metal Building |
| Tank Farm Area | Prior of 1987 | Concrete and Tanks |
| Coal Handling | 1991 - 1992 | |
| Conveyor to Crusher 55’ | | Steel Truss, Partially Covered |
| Crusher Transfer | | Engineered Steel Building |
| Conveyor to Bin 145’ | | Steel Truss, Partially Covered |
| Truck Loadout Bin - 575 Ton | | Structural Steel |
| Tipple Electrical Facility | 1994 | Metal Building |
| Twin Fan | 1993 - 1994 | Structural Steel, Formed Plate |
| Water Treatment Plant | 1994 | Metal Building |
| High Pressure Water Facility | 1993 | Metal Building, Steel Tank |
| Fuel Storage Area<br>Tanks - 15,000 (1):5,000 (2) | 1993 | Concrete & Steel Tanks |
| Sediment Controls including<br>Pond | 1987 | |
| Storage Shed | After 1992 | |
| Storage Dock | After 1992 | |
| Salt Storage Shed - Covered | 1998 | |
| | | |

### 526.200 Utility Installation and Support Facilities

Refer to Section 526.100 for utilities and facilities associated with the mine site.

Support facilities at the Mine will be operated in accordance with the permit issued for the mine. Support facilities will be located, maintained, and used in a manner that:

- Prevents or controls erosion and siltation, water pollution, and damage to public or private property,
- To the extent possible, using the best technology currently available, minimizes damage to fish, wildlife, and related environmental values, and minimizes additional contributions of suspended solids to streamflow or runoff outside the permit area.

### 526.300 Water Pollution Control Facilities

Water pollution control facilities at the Mine consist of the sedimentation pond, the appurtenant structures associated with the sedimentation pond, ditches, culverts, curb and gutter, etc. Three water diversion structures are maintained at the Mine. A concrete curb and gutter running north-south through the facilities area diverts water from the disturbed area into the sediment pond. A 66-inch culvert that has been placed in Cottonwood Creek has allowed the facilities pad area to be extended and allow Cottonwood Creek to flow beneath the mining operation. The length of this culvert is approximately 1,900 feet, extending from below the sedimentation pond to the property boundary north of the bathhouse. A 48-inch culvert located at the mouth of the side canyon, just west of the fan portal, diverts water from the canyon directly into the 66-inch culvert of Cottonwood Creek without crossing the surface of the mine property (see Section 532).

A sedimentation pond is located on the southern end of the permit area. All surface water that has crossed the mine property is diverted to this structure. Mine water can also be periodically pumped directly into the sediment pond. The pond contains a 48-inch emergency overflow culvert and a decant pipe, located on the east side of the pond (see Section 532).

## 527 Transportation Facilities

### 527.100 Road Classification

There is one primary road for the mining operation which is used to haul coal. The primary road serves the truck loadout and is approximately 825 feet long and 12 feet wide. The trucks will

enter the north end of the road and exist on the south. The remaining roads on site are ancillary roads. These include the upper terrace access road, portal access road and the tipple access road.

A primary road provides access to the Waste Rock Storage Facility. A professional engineer has certified the design and construction of the road as meeting the requirements of R645-301-534.200 and R645-301-742.420.

The Applicant will not require approval of the Division for alternative road specifications, or for steep cut slopes.

### 527.200 Description of Roads and Conveyors

Roads will be maintained to meet applicable design standards throughout their use, by blading, watering and resurfacing as necessary. Roads are also located, designed, constructed, reconstructed, used, maintained, and will be reclaimed to prevent or control damage to prelaw public or private property; using non-acid or non-toxic forming substances in surfacing.

The facilities area of the Mine is accessed from a county road (see Plate 5-2).

## 528 Handling and Disposal of Coal, Overburden, Excess Spoil, and Waste

### 528.100 Coal Handling

Coal handling conveyors will be constructed on the surface at the mine site. The mine conveyor will transport coal from the mine to the coal stock pile. The reclaim belt will convey coal from the stock pile (via a reclaim tunnel) to the crushing facility. The loadout belt will convey coal from the crusher to the truck loading bin, from which the coal will be loaded into trucks for off-site transport. Each conveyor will be of sufficient size to handle the production levels coming from the mine and the anticipated truck loading rates. Conveyor widths will range from 42 to 60 inches.

The mine does not have a coal preparation plant.

### 528.200 Overburden

No overburden is removed, handled, stored, or transported within the permit area.

### 528.300 Spoil, Processing Waste Mine, Development Waste, Noncoal Waste

No spoil is generated at the mine. The Mine does not process its coal beyond crushing and screening. Thus, no coal processing waste is generated in the permit area. The Applicant has no plans to return coal processing waste to abandoned underground workings.

Non-coal mine wastes and other combustible materials generated during mining activities will be placed and stored in a controlled manner in a designated location. Once a sufficient amount of this waste accumulates to justify removal, the non-coal waste and materials that constitute a potential fire hazard are loaded onto a truck and hauled by a licensed contractor to a state approved waste disposal area. The Applicant does not plan any on-site disposal of non-coal mine wastes.

Waste oil is collected in a designated storage area at the site. A licensed contractor will pick up hydrocarbons on a regular basis and remove it for recycling purposes. No non-coal waste that is defined as hazardous under 40 CFR 261 is currently generated at the mine. If such waste is generated in the future, it will be handled in accordance with the requirements of associated regulations.

Underground development waste is kept underground as allowed by MSHA. In the event this material must be brought out of the mine, it will be hauled to the Waste Rock Site and disposed of in an approved manner.

Data presented in the waste rock site volume of this M&RP and in Chapter 6 indicate that no materials at the site are acid forming.

### 528.400 Dams, Embankments and Impoundments

No dams, embankments, or impoundments are used for the handling or disposal of coal, overburden, excess spoil or coal mine waste in the permit area.

### 529 Management of Mine Openings

Each underground mine opening is protected from deterioration through the installation of steel or concrete portal liners, steel sets, and timbers. A mine entry which is temporarily inactive, will consist of a chain link or other substantial wire mesh fabric fence placed over the portals to prevent public access while allowing for air flow. Warning signs will be posted to identify the hazardous nature of the opening.

Historic Information - Five portals provided access to the Mine. A plan to construct permanent seals was submitted to and approved by Mine Safety Health Administration. Sealing of the mine portals was completed on May 1, 2001. These portals may be reopened at a later date. Five portals provide access to the Mine. One portal located on the corner of the outcrop of Cottonwood Canyon and a small side-drainage canyon is a fan portal. The second portal, 150 feet south of the fan portal, is the main intake and travel portal. The third portal is the belt portal. It is located just to the south of the main portal. The fourth portal is south of the belt portal and is used as a ventilation portal.

A fifth portal has been driven to the outside approximately 1000' south of the fourth portal. Complete description of this project is found in Appendix 5-7. (See Plate 5-2 for locations). An old sealed entry is found 500 feet south of the fourth portal (ventilation portal). All portals associated with the Mine were sealed as specified in 30CFRPart 75335 (except one (1) opening which was inaccessible, this opening was completely backfilled with non-combustible fill from the surface).

## 530 Operational Design Criteria and Plans

### 531 General

One sedimentation pond with corresponding runoff control facilities was constructed to provide sediment control for the Mine. The layout of the sedimentation control plan, including pond location, pond drainage area boundary, ditches and berms, are illustrated on Plate 5-8.

No minable coal exists beneath the mine site sedimentation pond or the Waste Rock sedimentation pond. Thus, subsidence will not affect operation of the ponds.

### 532 Sediment Control

The sedimentation pond is sized to contain runoff from the area of the mine facilities. As shown in Plate 5-8, there are no diversion ditches for undisturbed area runoff. A description of the Mine's sediment controls in provided in Section 732, 733 and 734.

Runoff from the side canyon above the operation will be bypassed through a culvert connected into the Mine site Cottonwood Creek large bypass culvert. Drainage areas for the side canyon culvert and Cottonwood Canyon culvert are shown on Plate 7-6. Drainage areas for the disturbed and undisturbed drainage to the sediment pond are shown on Plate 7-5.

A diversion culvert and curb and gutter system conveys runoff from the disturbed area to the sedimentation pond. The diversion culverts for Cottonwood Creek were designed and sized by the U.S. Forest Service and the Division of Oil, Gas and Mining to pass runoff from the 50 year, 24-hour storm (from Miller et al. (1973), Figure 39, page 41]. See Appendix 7-3 for Culvert Specifications, Appendix 7-13 for Culvert Extension Details and Plate 5-15 for Cross Sections.

Peak flows and peak flow design related information for the diversion ditch and culverts are contained in Table 5-7. Design criteria and calculation results for sizes and flows in the diversion system at maximum discharge are presented in Table 5-12.

The design flood includes all of the Cottonwood Canyon runoff, down to and including the side drainage and the three culvert inlets from the opposite side of the highway, as shown on Plate 5-9.

Other minor inlets to the sediment pond include a small road and pad area at the top of the switchback above the pond. A culvert which picks up a small amount of road drainage below the gate was installed in 1988 to catch runoff below the gate which may contain dust or mud carried onto the highway by the haul trucks. A third minor inlet was the mine water discharge line located in the 2nd portal south of ROM belt portal. The disconnected discharge line was optionally used to channel mine water discharge through the sediment pond in lieu of discharging directly to Cottonwood Creek. A replacement line discharges mine water to a storage tank. From the storage tank, water can be discharged to an existing 48" culvert as shown on Plate 5-9. All inlets are shown on Plate 5-9. Design criteria and sizing are shown in Table 5-12.

"BTCA" Areas - It should be noted that two small areas of disturbance do not drain to the pond. Refer to Section 732 for additional information on BTCA areas. The described "BTCA" areas are shown on Plates 3-1 and 7-5.

Sedimentation Pond Design - The sedimentation pond was designed to contain sediment storage volume from 0.05 acre-feet of sediment per acre to disturbed area. Spillway capacity requirements for the sedimentation pond were based on runoff from the 25-year, 24-hour storm (2.9 inches). Table 5-9 contains the volume and spillway capacity requirements for the pond as well as additional design related information.

The pond design details for the sedimentation pond are illustrated on Plate 5-8. The sedimentation pond consists of a sediment storage pool, a dead pool, and a runoff

control pool equal to the inflow volume from a 10-year, 24-hour storm (2.4 inches). A dewatering device is placed in the pond to draw the pond level down to the bottom of the runoff control pool in anticipation of a future runoff event. The Utah Division of Environmental Quality requires that no dewatering device be placed within three feet of the top of the sediment cleanout level (60 percent); therefore, a dead storage pool has been created to meet the requirements of both agencies. The proposed principal and emergency spillway system consists of a corrugated metal riser and conduit with an anti-vortex device, trash rack, and anti-seep collars. Utilizing Equation 5-1, which defines orifice flow, the discharge capacity of the riser-conduit combination with a diameter of 48 inches was found adequate in passing the peak inflow resulting from the 25-year, 24-hour storm.

Orifice flow occurs when the flow is restricted by the opening and can be determined as;

$$q = CA\,(2gH)^2 \qquad (5\text{-}1)$$

where q is as previously defined; C is a coefficient dependent upon the orifice geometry (0.6 in this case); A is the cross-sectional area of the opening, in square feet; g is the gravitational constant (32.2 feet per second squared); and H is the head above the orifice inlet, in feet. The orifices considered are the riser inlet and the inlet of the conduit leading from the riser through the pond embankment.

The total embankment height was obtained by adding the stage at full storage capacity, the head of water over the spillway under design flow conditions, the required freeboard height (1.0 feet), and a five percent settlement allowance. The embankment top width will not be less than (H + 35)/5 where H is the height of the embankment, in feet. Table 5-10 summarizes the design specifications for the sedimentation pond.

The sedimentation pond is constructed between the excavated slope of the old pond and a new embankment constructed over the 66-inch culvert. The excavated slope of the old pond was approximately equal to 1.06H:1V. To obtain the necessary pond storage capacity, the remaining inside slopes of the pond was designed at 2h:1V. The pond is

lined with 18 inches of a 10:1 mixture of the embankment material and bentonite, respectively, to prevent seepage and piping.

The dewatering device consists of a 12-inch corrugated metal riser and an 8-inch conduit drain line, antivortex device, trash rack, and anti-seep collars. The anti-vortex also acts as a skimming device by not allowing water to be pulled directly from the surface of the pond. A water control gate valve is located at the end of the 8-inch diameter corrugated metal conduit within the 48-inch spillway within the pond embankment to allow efficient water release.

This was necessitated by the facts that:

1) The water control gate valve must be installed in the manhole/spillway to allow access to the valve;

2) The location of the riser does not allow access to the gate if placed at the extreme inlet;

3) Gates were apparently not available which could beattached between two culverts in a watertight manner; and

4) It was desirable to allow access to the control gate for maintenance purposes.

The control gate operator mechanism is located above the spillway cover. Access to the gate for maintenance can be made via a ladder or rebar rungs which have been welded to the spillway side. A walkway has been installed to allow access to the control gate for purposes of dewatering and inspection. Anti-seep collars have been used based on methods outlined by the U.S. Environmental Protection Agency (1976). Plate 5-8 shows the location and size of the anti-seep collars.

Riprap was placed in the inlet channels, on the inside slope of the pond and below the outlet conduit of the pond to dissipate energy and reduce erosion potential. The outlet culvert from the pond discharges onto the riprap protection on the main channel as described in Appendix 7-3.

The sedimentation pond will be inspected quarterly, and a copy of the inspection report will be kept at the mine site and an engineer certified copy sent to the Division.

Sediment Disposal Plans - Sediment will be cleaned out at approximately 60 percent of the sediment storage level. The point at which cleanout becomes necessary is approximately 11.2 feet below the top of the riser. Sediment removed from the pond will be temporarily stored within the drainage basin to the pond and eventually disposed of at the Waste Rock Facility.

Pond Reclamation - The disturbed area of the pond has been seeded with the interim (contemporaneous) seed mix. Permanent reclamation of the pond is discussed under Sections 540 and 763.

The design of the Waste Rock pond is in a separate volume of this M&RP.

## 533 Impoundments

### 533.100 Slope Stability

Appendix 5-1 presents the stability analyses of the sediment pond. The sedimentation pond embankment was analyzed by the Stable 2 program under dry pond conditions, with a horizontal acceleration of 10 percent of gravity assumed, and under full pond conditions with the 10 percent horizontal acceleration also assumed. These represent the worst-case conditions and thus, static dry pond, static full pond and rapid drawdown conditions were not analyzed. The minimum factor of safety of 2.38 was under the full pond with earthquake analysis.

The minimum factor of safety for the sediment pond at the waste rock disposal area is 1.3 under the full reservoir with seismic loading.

### 533.200 Foundation Considerations

Prior to construction of each sedimentation pond, vegetative matter and topsoil was removed from the foundation area. Stability of the ponds has been enhanced through the installation of cutoff trenches and anti-seep collars. Detailed cross sections of the sedimentation pond are presented on Plate 5-8. The slope-stability analyses presented in Appendix 5-1 indicate the pond foundations will be stable under operating conditions.

### 533.300 Slope Protection

The outslopes and inslopes of the sedimentation ponds were contemporaneously revegetated following construction to minimize surface erosion and protect the embankments. In the event of a storm, rapid drawdown in the sedimentation pond would be restricted to the vertical distance between the spillway and the peak water level, a distance of 8.0 feet. The flow is restricted by the 8-inch diameter CMP drain line, is controlled and is unlikely to cause surface erosion.

### 533.400 Embankment Faces

Embankment inslopes and outslopes were revegetated, in addition riprap was placed on the upstream and downstream faces of the embankments.

### 533.500 Highwalls

No highwalls are located below the water lines of the sedimentation ponds.

### 533.600 MSHA Criteria

No sedimentation ponds in the permit area meet the size criteria of 30 CFR 216(a).

### 533.700 Pond Operation and Maintenance Plans

The sedimentation pond is designed in accordance with R645-301-740. The design of the sediment pond was performed by, or under the direction of, and certified by a qualified, registered, professional engineer. Details of the design are presented in this chapter and on Plate 5-8.

The sedimentation ponds are operated as containment structures, with primary and emergency spillways to discharge water during a storm that exceeds the design capacity. Excess water following a runoff event is held in the ponds until the suspended sediment settles. Water is decanted in accordance with the discharge permit and 40 CFR 434 effluent limitations.

Maintenance that is required to keep the ponds in good working condition is performed as soon as practical following discovery of a maintenance requirement. The sediment pond will be left in place to treat reclaimed area runoff as described in Section 542.

## 534 Roads

### 534.100 Location, Design, Construction, Maintenance and Reclamation

Primary and ancillary roads associated with the surface facilities are designed and constructed to prevent damage to public property. No acid- or toxic-forming materials have been used in the road surfaces. Safety and environmental protection were primary concerns during the design and construction of the mine roads. Additional information is in Section 527.

For the construction of roads on site, vegetation material and topsoil will be removed from the design road bed, shoulders, and surfaces. Topsoil will be placed in a topsoil stockpiles located on site. The material for the embankment shall be reasonably free of material considered unsuitable for use in embankment construction.

### 534.200 Environmental Protection and Safety

The roads on site will be watered as necessary to control air pollution. Roads will be routinely maintained. A road damaged by a catastrophic event, such as a flood or earthquake, shall be repaired as soon as is practicable after the damage has occurred.

### 534.300 Primary Roads

The primary road constructed at the mine facility is in the stable bottom of the canyon adjacent to the County road. The roads will be plated with at least 6-inches of road base gravel, routinely maintained and include minor reconstruction of road segments as necessary. The primary road on site does not have any significant embankment so the minimum static factor of 1.3 should not apply. For additional information refer to Section 527.

## 535 Spoil

Refer to Section 528.

## 536 Coal Mine Waste

The design of the waste rock disposal area contains:

- A description of pre-disturbance soils at the site and the suitability of the waste rock for reclamation,
- Certification of the design and plans,
- Compliance with applicable MSHA regulations,
- A description of proposed inspection activities,
- A description of the design, stability, operation, and reclamation of the waste-rock site, and
- A discussion of runoff- and sediment-control plans associated with the site.

## 537 Regraded Slopes

### 537.100 Division Approval

No mining or reclamation activities are conducted in the permit area that require approval of the

UDOGM for alternative specifications or for steep cut slopes due to the inability of the Mine to meet regulatory requirements.

### 537.200 Regrading of Settled and Revegetated Fills

The Applicant is requesting a variance from the approximate original contour requirements of R645-301-553.600. The variance request is not based on the presence of settled and revegetated fills. The surface of this area was originally disturbed in the 1940's by a previous owner. The surface is privately owned. There is no record of the original contours. Since no major effort was made at that time to save or store any topsoil or other material, restoration to approximately original contour is highly impractical. However, it is the intent of the Applicant to restore the topography of area to be compatible with the post-mining land use, using materials available at the site.

## 540 Reclamation Plan

### 541 General

#### 541.100 Commitment

Upon the permanent cessation of coal mining and reclamation operations at the Mine, the Applicant will close, backfill, or otherwise permanently reclaim affected areas in accordance with the R645 regulations and this reclamation plan. Structures and facilities will be removed following mining in accordance with the reclamation plan.

#### 541.200 Surface Coal Mining and Reclamation Activities

No surface coal mining or associated reclamation activities are conducted in the permit area.

#### 541.300 Underground Coal Mining and Reclamation Activities

Upon completion of mining activities, surface structures will be removed, with the exception of portions of the culverts and the sediment pond as described in the following section. Salvageable materials will be hauled off-site , non-salvageable items will be removed and sent

to an approved land fill (i.e. - Emery County Landfill). Concrete will be broken up by equipment and either placed against the slopes prior to backfilling or hauled to an approved landfill.

### 541.400 Environmental Protection Performance Standards

The plan presented herein is designed to meet the requirements of R645-301 and the environmental protection performance standards of the State Program.

## 542 Narratives, Maps and Plans

### 542.100 Reclamation Timetable

A timetable for the completion of each major step in the reclamation plan is presented in Table 3-3.

### 542.200 Plan for Backfilling, Soil Stabilization, Compacting, and Grading

The regrading plan for the waste rock disposal facility is presented in a separate volume of this M&RP. Regrading the waste rock facility will occur on a continuing basis as the rock is emplaced.

Due to the close proximity of the mine site to a stream, it is proposed to leave the sediment pond in place to treat reclaimed area runoff until revegetation standards are reached. To direct the runoff, a 40' length of 48" CMP will be left in place at the point where the restored side canyon drainage meets the restored main channel, as shown on Plate 5-12.

The reclaimed area will be bermed along the restored side canyon drainage where it meets the restored main channel, as shown on Plate 5-12. The reclaimed area will be bermed along the restored banks of the channels to direct runoff to the sediment pond. Approximately 300' of 66" culvert (with the 96" to 66" transition and trash rack) will be left in place beneath the pond to convey the undisturbed Cottonwood Canyon drainage. Other diversions and culverts will be removed during this Phase I of final reclamation. Once revegetation standards are reached, the sediment ponds and remaining culvert sections will also be removed, and the remaining disturbed area will be reseeded. Additional sediment controls, such as straw bales, straw logs,

silt fences, berms, etc., will be placed as needed to ensure protection for the stream during this final phase of reclamation (Phase II).

With the separation of the Trail Mountain Mine (renamed Fossil Rock 2015) from the PacifiCorp/Energy West operations it has been brought to the permittee's attention that three culverts with inlets on the east side of the Emery County Road adjacent to the Fossil Rock Mine and Deer Creek Mine have outlets on the west side of the County Road. The outlets are not visible and are assumed to connect into the 66-inch undisturbed water bypass culvert. The culvert construction information was not in the permitting transferred from PacifiCorp to the permitee. The ability to determine where and at what elevation the outlet of the three culverts enter the channel is unknown. Engineered designs and details would be conjecture and could therefore be commitments that are not possible to meet. For that reason and following consultation with a permitting supervisor at the Division, the permittee commits at reclamation to use BTCA to place an appropriately sized outlet and erosion protection in the channel at the outlet location of each of the three culverts.

A perpetual discharge from the sealed Cottonwood Mine portals is located on the east side of the mine site. This discharge flows under the Emery County road via a culvert and connects to the bypass culvert. At reclamation, the Applicant will install an outfall splash apron with scour cutoff Key to accept the discharge from the culvert into the creek (See Plate 5-10). Due to the lack of information regarding the exact location and orientation of the culvert, it is assumed that the culvert projects exactly perpendicular to the road and is exactly level with the effluent entry point, the design accounts for these assumptions. The Applicant accepts no responsibility for the quality of the discharge water at this location. It is assumed that the UPDES permit holder of this discharge point takes all responsibility for the quality of the discharge according to their permit.

Historic Dates assumed for construction:

- The 96-inch to 66-inch transition and trash rack were constructed in (1981 – 1982)
- Culvert installation when road constructed (assumed 1986-1987) -Easement Documents dated January and July 1986 between US Forest Service, Emery County and the LDS Church

With special handling, the disturbed land should provide a suitable seed bed for revegetation. The mine coal pad areas will be removed, and coal/refuse associated with the pads will be hauled to the Cottonwood Waste Rock Site for disposal.

Contaminated soil material which contains greater than 50 percent coal fines, will be disposed of at the Waste Rock Site. This will be determined by visual inspection, and any material with visible oil or grease contamination will be removed and disposed of at an approved site.. The volume of such material cannot be accurately estimated; however, it will likely be less than two percent of total volume. Material with less than 50 percent coal fines will be buried against the cut banks and covered with a minimum of four feet of incombustible material. There are no acid- or toxic forming materials known to exist at this site.

Salt contamination may also be a problem in soils used for reclamation. If visible salty areas or analyzed salty areas are found, the soils will be buried along the cut banks or other available sites to a minimum depth of 48".

The pad areas will be ripped for 12 to 24 inches to loosen the fill profile. Once backfilled and graded, the surface will be scarified with the teeth on the backhoe or using the tracks of the dozer to create "pockets" for water retention and root penetration.

In general, backfilling and grading operations will be conducted in a controlled manner and will proceed as follows:

a) After sealing of the portals and removal of structures, a backhoe will be brought to the upper (portal road) terrace. The backhoe will begin by reaching down over the fill bank and retrieving as much material as can be reached. This material will be placed on the terrace.
b) Other appropriate equipment will work with the backhoe where possible, taking the retrieved material and spreading and compacting it from the cut outward to reach a configuration as shown on Plate 5-13, Post-Mining Contour Map.

c) The mine yard will then be re-sloped to drain as shown. A rock-lined natural drainage will be restored in the main and side channels as previously described.

d) The reclaimed area will be left in a roughened condition by placement of material with the backhoe and subsequent ripping and/or tracking with the dozer if necessary. One ton per acre of noxious weed free straw will be incorporated into the soil during surface roughening. This will provide for increased moisture retention and favorable micro sites for plant establishment.

e) The reclaimed area will be protected from livestock grazing until bond release by fencing. The proposed fence is shown on Figure 5-9 and is not intended to preclude wildlife access. The revegetated area will be observed on a yearly basis. If heavy use occurs by wildlife, rodents, etc. other protection measures will be implemented.

f) Available topsoil, from the storage pile, will be used to restore the riparian area, starting at the north end of the riparian area, and continuing down as far as material is available.

g) Upon final shaping and preparation of an area, it will be reseeded as per the plan after soil sampling is performed.

h) Soil sampling techniques are explained in Chapter 2, 224 Substitute Topsoil.

Plate 5-13 shows the post mining contours of the Mine. Upon abandonment, the post mining land use will not require extensive backfilling or returning the land to the original contours, however, areas which are compacted through the reclamation activities or during mining will be "deep-ripped" to a depth of 12" to 24" prior to seeding.

The drainage channels will be graded to reestablish the streams, following removal of the bypass culverts. Attempts will be made to restore the channels to the pre-mining slopes and conditions.

Highwalls (cut areas associated with portals) will be reclaimed as is practicable for the site and for the post mining land use. A static factor of a least 1.3 will be developed in the reclaimed highwall. Other cut areas exist on this site; however, these are primarily road or pad cuts and do not fit the definition of a highwall. Portions of these areas may be retained as terraces to enhance the stability of road backfills.

Measures for erosion control will be implemented on a case by case basis. Some methods which might be used are: mulching, straw dikes, water bars, silt fence, and limiting access to the area.

The berms along the reclaimed channels will be checked for erosion in the flow paths. If signs of erosion are evident, erosion controls such as loose rock check dams or silt fences will be installed along at intervals of 500' or less as necessary to control the erosion. Rills or gullies deeper than nine inches in regraded areas will be filled, graded or otherwise stabilized and reseeded as per the plan. This will be accomplished by hand, using adjacent or eroded material whenever possible. If larger gullies develop, a backhoe may be used in addition to hand work and existing material will be used to accomplish this task.

### 542.300 Final Surface Configuration Maps and Cross Sections

Plates 5-12 and 5-13 show the post mine contours. Post mining cross sections are shown on Plates 5-14A and 5-14B.

### 542.400 Removal of Temporary Structures

Surface structures associated with the mining operation will be removed as outlined in Section 541.300.

### 542.500 Removal of Sedimentation Ponds

The sediment pond and other siltation structures will be maintained until removal is authorized by the Division and the disturbed area has been stabilized and revegetated. In no case will the structure be removed sooner than two years after the last augmented seeding.

### 542.600 Roads

Roads will be reclaimed after they are no longer needed for mining and reclamation operations. Culverts associated with roads will be removed. The reclamation process will scarify and rip the

roadbeds. The disturbed area will be revegetated. The gravel surfacing from the road beds will be incorporated into the soils.

#### 542.700 Final Abandonment of Mine Openings and Disposal Areas

Upon completion of mining activities, the portals will be sealed in accordance with State and Federal regulation. A typical drawing of portal sealing to be used is shown in Figure 5-7. Seals will be located at least 25' inside the portal entry. Loose material around the seal area will be removed for roof, rib and floor prior to installation.

See Section 528.300 for information on waste.

The waste rock disposal area will be reclaimed and abandoned as outlined in this M&RP.

#### 542.800 Estimated Cost of Reclamation

The estimated cost of reclamation of the mine site is shown in Appendix 5-1.

## 550 Reclamation Design Criteria and Plans

### 551 Casing and Sealing of Underground Openings

Underground opening to the mine will be sealed and backfilled when no longer needed. Permanent closure measures will be as described in Section 542.700. A typical drawing of portal sealing is shown in Figure 5-7.

Exploration drill holes will be sealed to BLM specifications, per Figure 5-8.

### 552 Permanent Features

#### 552.100 Small Depressions

Small depressions will be constructed to retain moisture, minimize erosion, create and enhance wildlife habitat, or assist revegetation.

### 552.200 Permanent Impoundments

No permanent impoundments will be left following reclamation.

## 553 Backfilling and Grading

Plans for backfilling and grading of the site upon reclamation have been presented in Section 542.200. This plan was designed to comply with the applicable requirements of R645-301-500 and R645-301-700. As indicated in Section 542.200, backfilling and grading operations will be conducted in a controlled manner.

Earthwork estimates for final reclamation are summarized in the Mass Balance Table 5-4. The quantities are taken from cross-sectional areas shown on Plates 5-14A and 14B. Cross section locations are shown on Plates 5-12 and 5-13. Estimates indicate a cut volume of 38,579 cubic yards and a required fill volume of 39,719 cubic yards for final mine site reclamation.

### 553.100 Disturbed Area Backfill and Grading

Highwalls will be eliminated as stated in Section 542.200. Small depressions will be constructed in accordance with Section 552.100. No spoil piles exist.

Backfilled and regraded slopes have been designed to be no steeper than 30 degrees (1.75H:1.0V). The stability analysis located in Appendix 5-1 shows fill slopes with a 30-degree slope have a minimum factor of safety 2.0, thus preventing slides. Appendix 5-1 indicates the post-mine fill should be placed in loose lifts not to exceed two feet in thickness and compacted to 80 to 85 percent Standard Proctor density in order to approximate equivalent undisturbed soil conditions and to stabilize the fill mass. Large rocks should be scattered and grouped to provide wildlife habitat. The top two feet of the fill will be left in a generally loose condition to facilitate revegetation.

There will be remnant steep slopes above the post mine fill. Appendix 5-1 incorrectly refers to these slopes at remnant highwalls. The remnant steep slopes will have a minimum factor of safety of 2.0.

Temporary sediment-control measures will be implemented following backfilling and regrading as outlined in Section 542.200. As vegetation becomes established on the reclaimed surfaces, erosion potentials will be further minimized and water pollution will also be precluded.

Following completion of the mining operations the area will be graded, scarified, and seeded (See Section 341). The paved access road to the mine has varied ownership (county, federal and private) and provides access for Mine, Forest Service and private land up Cottonwood Canyon.

### 553.200 Spoil and Waste

See Section 528.300 for information on waste.

### 553.300 Exposed Coal Seams, Acid- and Toxic-Forming Materials

Exposed Coal Seams. Coal seams exposed during mining will be covered with a minimum of four feet of nontoxic and noncombustible materials during final backfilling and grading.

Acid- and Toxic-Forming Materials. No acid-forming materials exist at the site (see Section 528).

Combustible Materials. See Section 528.300 for information on waste.

### 533.400 Cut and Fill Terraces

Terraces are not going to be used during final grading operations.

### 553.500 Highwalls from Previously Mined Areas

Not applicable to this operation.

### 553.600 Approximate Original Contour – PMA's & CMA's

Not applicable to this operation.

### 553.700 Backfilling and Grading - Thin Overburden

No surface coal mining and reclamation activities involving thin overburden occur within the permit area.

### 553.800 Backfilling and Grading - Thick Overburden

No surface coal mining and reclamation activities involving thick overburden occur within the permit area.

### 553.900 Regrading of Settled and Revegetated Fills

No regrading of settled and revegetated fills is anticipated in the permit area.

## 560 Performance Standards

Coal mining and reclamation operations at the Mine will be conducted in accordance with the approved permit and the requirements of R645-301-510 through R645-301-553.

TABLE 5-4 MASS BALANCE

| STATION | CUT VOLUME CU. YDS. | FILL VOLUME CU. YDS. | ACC. CUT VOLUME CU. YDS. | ACC. FILL VOLUME CU. YDS. |
|---|---|---|---|---|
| 0+00 | 0 | 0 | 0 | 0 |
| 2+00 | 1,556 | 1,467 | 1,556 | 1,467 |
| 4+00 | 3,778 | 3,022 | 5,334 | 4,489 |
| 6+00 | 4,889 | 4,519 | 10,223 | 9,008 |
| 8+00 | 6,222 | 6,148 | 16,445 | 15,156 |
| 10+00 | 5,511 | 5,482 | 21,956 | 20,638 |
| 12+00 | 4,341 | 3,259 | 26,297 | 23,897 |
| 14+00 | 3,719 | 3,170 | 30,016 | 27,067 |
| 16+00 | 2,533 | 3,926 | 32,549 | 30,993 |
| 18+00 | 3,185 | 3,511 | 35,734 | 34,504 |
| 20+00 | 2,415 | 2,400 | 38,149 | 36,904 |
| 22+00 | 430 | 1,200 | 38,579 | 38,104 |
| 24+00 | 0 | 1,274 | 38,579 | 39,378 |
| 25+00 | 0 | 341 | 38,579 | 39,719 |
| TOTALS | 38,579 | 39,719 | 38,579 | 39,719 |

NOTES: (1) Refer to Plates 5-12 and 5-13 for cross sections locations and (2) Refer to Plate 5-14A,B,C,D for cross sections

# Table 5-2
## Runoff Curve Numbers for Hydrologic Soil-Cover Complexes
### (Antecedent moisture condition II, and Ia - 0.2S)

| Land Use | Cover: Treatment or Practice | Hydrologic Condition | Hydrologic Soil Group | | | |
|---|---|---|---|---|---|---|
| | | | A | B | C | D |
| Fallow | Straight Row | ----- | 77 | 86 | 91 | 94 |
| Row Crops | " | Poor | 72 | 81 | 88 | 91 |
| | | Good | 67 | 78 | 85 | 89 |
| | Contoured | Poor | 70 | 79 | 84 | 88 |
| | " | Good | 65 | 75 | 82 | 86 |
| | " and Terraced | Poor | 66 | 74 | 80 | 82 |
| | " and Terraced | Good | 62 | 71 | 78 | 81 |
| Small Grain | Straight Row | Poor | 65 | 76 | 84 | 88 |
| | " | Good | 63 | 75 | 83 | 87 |
| | Contoured | Poor | 63 | 74 | 82 | 85 |
| | " | Good | 61 | 73 | 81 | 84 |
| | " and Terraced | Poor | 61 | 72 | 79 | 82 |
| | " and Terraced | Good | 59 | 70 | 78 | 81 |
| Close-seeded | Straight Row | Poor | 66 | 77 | 85 | 89 |
| Legumes[1] or | " | Good | 58 | 72 | 81 | 85 |
| Rotation Meadow | Contoured | Poor | 64 | 75 | 83 | 85 |
| | " | Good | 55 | 69 | 78 | 83 |
| | " and Terraced | Poor | 63 | 73 | 80 | 83 |
| | " and Terraced | Good | 51 | 67 | 76 | 80 |
| Pasture or Range | | Poor | 68 | 79 | 86 | 89 |
| | | Fair | 49 | 69 | 79 | 84 |
| | | Good | 39 | 61 | 74 | 80 |
| | Contoured | Poor | 47 | 67 | 81 | 88 |
| | " | Fair | 25 | 59 | 75 | 83 |
| | " | Good | 6 | 35 | 70 | 79 |
| Meadow | | Good | 30 | 58 | 71 | 78 |
| Woods | | Poor | 45 | 66 | 77 | 83 |
| | | Fair | 36 | 60 | 73 | 79 |
| | | Good | 25 | 55 | 70 | 77 |
| Farmsteads | | ----- | 59 | 74 | 82 | 86 |
| Roads (dirt)[2] | | ----- | 72 | 82 | 87 | 89 |
| (hard surface)[2] | | ----- | 74 | 84 | 90 | 92 |
| Industrial Area | | ----- | 81 | 88 | 91 | 93 |

[1] Close-drilled or broadcast

[2] Including right-of-way

TABLE 5-4 MASS BALANCE

| STATION | CUT VOLUME CU. YDS. | FILL VOLUME CU. YDS. | ACC. CUT VOLUME CU. YDS. | ACC. FILL VOLUME CU. YDS. |
|---|---|---|---|---|
| 0+00 | 0 | 0 | 0 | 0 |
| 2+00 | 1,556 | 1,467 | 1,556 | 1,467 |
| 4+00 | 3,778 | 3,022 | 5,334 | 4,489 |
| 6+00 | 4,889 | 4,519 | 10,223 | 9,008 |
| 8+00 | 6,222 | 6,148 | 16,445 | 15,156 |
| 10+00 | 5,511 | 5,482 | 21,956 | 20,638 |
| 12+00 | 4,341 | 3,259 | 26,297 | 23,897 |
| 14+00 | 3,719 | 3,170 | 30,016 | 27,067 |
| 16+00 | 2,533 | 3,926 | 32,549 | 30,993 |
| 18+00 | 3,185 | 3,511 | 35,734 | 34,504 |
| 20+00 | 2,415 | 2,400 | 38,149 | 36,904 |
| 22+00 | 430 | 1,200 | 38,579 | 38,104 |
| 24+00 | 0 | 1,274 | 38,579 | 39,378 |
| 25+00 | 0 | 341 | 38,579 | 39,719 |
| TOTALS | 38,579 | 39,719 | 38,579 | 39,719 |

NOTES: (1) Refer to Plates 5-12 and 5-13 for cross sections locations and (2) Refer to Plate 5-14A,B,C,D for cross sections

## Table 5-7
## Peak Flows and Peak Flow Design Related Information for Diversion Ditches and Culverts

| Structure | Disturbed Area (ac) | Undisturbed Area (ac) | Total Area (mi2) | Weighted Cn | Design Storm (in) | S (in) | Runnoff (Q) (in) | Hydraulic Length (ft) | Average Watershed Slope (%) | Watershed Lag (hr) | $t_p$ (hr) | Δ D (hr) | $484AQ/t_p$ | $C_3t_p$ | Peak Flow (q) (cfs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cottonwood Canyon Culvert** | | 11,969 | 10.7 | 57 | 3.2 | 7.54 | 0.31 | 40,000 | 36.5 | 1.74 | 2.09 | 1 | 1341.3 | 3.7 | 510 |
| **Side Canyon Culvert** | | 366 | 0.57 | 80 | 2.4 | 2.5 | 0.82 | 6,375 | 49.12 | 0.199 | 0.22 | 0.04 | 1032 | 0.83 | 80.1 |
| ***Sediment Pond Diversion** | 9.27 | 22.82 | 0.05 | 78.5 | 2.4 | 2.74 | 0.75 | 2,200 | 8 | 0.22 | | | | | 22.56 |

* SCS - TR55 Method

# Table 5-8
## Design Criteria
### Sediment Pond Inlets

| Location | | Curb/Gutter | | Switchback | Culvert from Road | Main Waterline |
|---|---|---|---|---|---|---|
| | | Upper Section | Lower Section | | | |
| Disturbed | | 9.550 | 8.800 | 0.180 | 0.287 | *** |
| Undisturbed Drainage Area | (ac) | 26.61 | 14.70 | 3.79 | *** | *** |
| Precipitation - 10yr/24hr | (in) | 2.4 | 2.4 | 2.4 | 2.4 | *** |
| Flow | (cfs) | 22.56 | 22.56 | 4.65 | 0.45 | 0.20 |
| Slope | (%) | 0.075 | 0.20 | 0.40 | 0.02 | *** |
| Bottom Width | (ft) | 0.01 | 0.01 | 0.01 | ***. | ***. |
| Side Slope | (h:v) | 4:1 | 5:1 | 2:1 | ***. | ***. |
| Manning's N | | 0.015 | 0.015 | 0.035 | 0.024 | ***. |
| Velocity | (fps) | 12.82 | 14.82 | 9.79 | 2.50 | ***. |
| Flow Depth | (ft) | 0.66 | 0.40 | 0.48 | 0.42 | ***. |
| Runoff CN | | 78.5 | 78.5 | 78.5 | 90.0 | ***. |
| Area Regulated | ($ft^2$) | 1.77 | 1.52 | 0.48 | 0.18 | ***. |
| Minimum Structure Area | ($ft^2$) | 2.00 | 1.77 | 1.00 | 3.14 | ***. |

## Table 5-8 - continued

### Channel Flow Calculation
### Curb/Gutter (Upper Section)

| | | | |
|---|---|---|---|
| Bed Slope | = | 0.075 | |
| Manning's N | = | 0.015 | |
| Bottom Width | = | 0.01 | feet |
| Channel Side Slope | = | 0.25 | |
| Flow Depth | = | 0.6620242 | feet |
| Cross Sectional Area | = | 1.759724 | square feet |
| Wetted Perimeter | = | 5.469192 | feet |
| Hydraulic Radius | = | 0.3217522 | feet |
| Discharge | = | 22.56 | cubic feet/sec |
| Velocity | = | 12.82019 | feet/sec |

## Table 5-8 - continued

### Channel Flow Calculation
### Curb/Gutter (Lower Section)

| | | | |
|---|---|---|---|
| Bed Slope | = | 0.2 | |
| Manning's N | = | 0.015 | |
| Bottom Width | = | 0.01 | feet |
| Channel Side ! | = | 0.1 | |
| Flow Depth | = | 0.38996175 | feet |
| Cross Sectiona | = | 1.521914 | square feet |
| Wetted Perime | = | 7.841215 | feet |
| Hydraulic Radi | = | 0.940917 | feet |
| Discharge | = | 22.56 | cubic feet/sec |
| Velocity | = | 14.82344 | feet/sec |

## Table 5-8 - continued

### Channel Flow Calculation
### Switchback Diverision

| | | | |
|---|---|---|---|
| Bed Slope | = | 0.4 | |
| Manning's N | = | 0.035 | |
| Bottom Width | = | 0.01 | feet |
| Channel Side Slope | = | 0.5 | |
| Flow Depth | = | 0.4849017 | feet |
| Cross Sectional Area | = | 0.4751083 | square feet |
| Wetted Perimeter | = | 2.17546 | feet |
| Hydraulic Radius | = | 0.218085 | feet |
| Discharge | = | 4.65 | cubic feet/sec |
| Velocity | = | 9.787243 | feet/sec |

## Table 5-8 - continued

### Channel Flow Calculation
### Culvert from Road

| | | | |
|---|---|---|---|
| Bed Slope | = | 0.02 | |
| Manning's N | = | 0.024 | |
| Bottom Width | = | 0.01 | feet |
| Channel Side Slope | = | 1 | |
| Flow Depth | = | 0.4196697 | feet |
| Cross Sectional Area | = | 0.1803193 | square feet |
| Wetted Perimeter | = | 1.197005 | feet |
| Hydraulic Radius | = | 0.1506421 | feet |
| Discharge | = | 0.45 | cubic feet/sec |
| Velocity | = | 2.495573 | feet/sec |

# Table 5-9

## Sediment Pond Storage and Spillway Capacity Requirements

| Variable | | | |
|---|---|---|---|
| Disturbed Area | acres | 9.55 | 9.98 |
| Undisturbed Area | acres | 26.61 | 26.61 |
| Total Area (A) | $mi^2$ | 0.056 | 0.057 |
| Weighted Curve Number (Disturbed Area) | | 78.5 | 78.5 |
| Weighted Curve Number (Undisturbed Area) | | 72.0 | 72 |
| S (disturbed) | inches | 2.74 | 2.74 |
| S (undisturbed) | | 3.89 | 3.89 |
| 25-year, 24-hour Precip. (P) | inches | 2.9 | |
| 25-year, 24-hour Runoff (Q). - Disturbed | inches | 1.22 | |
| 25-year, 24-hour Runoff (Q). - Undisturbed | inches | 0.75 | |
| Hydraulic Length (L) | feet | 2200 | |
| Average Watershed Slope (Y) | % | 8.0 | |
| Time of Concentration ($T_c$) | hours | 0.37 | |
| 25-year, 24-hour Peak Inflow | cfs | 36.46 | |
| 10-year, 24-hour Precip. | inches | 2.4 | 2.4 |
| 10-year, 24-hour Runoff - Disturbed | inches | 0.75 | 0.75 |
| 10-year, 24-hour Runoff - Undisturbed | inches | 0.48 | 0.48 |
| 10-year, 24-hour Runoff | ac-ft | 1.67 | 1.02295 |
| Sediment Storage Requirements | ac-ft | 0.47 | 0.499 |
| Pond Storage Requirements | ac-ft | 2.14 | 1.52195 |

# Table 5-10

## Sediment Pond Storage and Spillway Capacity Requirements

| | | |
|---|---|---|
| Sediment Storage Volume | ac-ft | 0.47 |
| Runoff Storage Volume | ac-ft | 1.67 |
| Total Storage Volume - Design Volume | ac-ft | 2.14 |
| Embankment Height at Design Volume | feet | 14.50 |
| Spillway Capacity | cfs | 36.50 |
| Spillway Diameter | inches | 48.00 |
| Head Above Spillway Crest as Design Discharge | feet | 0.80 |
| Required Freeboard | feet | 1.00 |
| Required Total Embankment Height | feet | 16.00 |
| Actual Embankment Height of Existing Pond | feet | 17.00 |
| Total Width | feet | 11 - 13 |

# Table 5-11

## Design Criteria
### Reclamation Hydrology

| Location | | Main Channel | Side Channel | Sediment Pond Inlet |
|---|---|---|---|---|
| Undisturbed Drainage Area | acre | 11,969 | 366 | 14.7 |
| Disturbed Drainage Area | acre | **** | **** | 2.4 |
| Precipitation 10yr/24hr | inches | **** | **** | 8.8 |
| Precipitation 100yr/24hr | inches | 3.80 | 3.80 | **** |
| Flow | cfs | 710.00 | 160.00 | 20.10 |
| Slope | % | 0.06 | 0.08 | 0.065 |
| Bottom Width | feet | 7.00 | 2.00 | 0.010 |
| Side Slope | H:V | 2:1 | 2:1 | 2:1 |
| Manning's N | | 0.04 | 0.04 | 0.04 |
| Velocity | fps | 15.02 | 11.67 | 6.24 |
| Flow Depth | feet | 3.42 | 2.16 | 1.27 |
| Area Required | sq. ft. | 47.28 | 13.71 | 3.22 |
| Min. Structure Area | sq. ft. | 72.00 | 24.00 | 4.00 |
| Rip-rap Required | Y/N | Y | Y | N |

# Table 5-11 - continued

## Channel Flow Calculation
## Main Channel

| | | | |
|---|---|---|---|
| Bed Slope | = | 0.06 | |
| Manning's N | = | 0.04 | |
| Bottom Width | = | 7 | feet |
| Channel Side Slope | = | 0.5 | |
| Flow Depth | = | 3.417295 | feet |
| Cross Sectional Area | = | 47.27688 | square feet |
| Wetted Perimeter | = | 22.28261 | feet |
| Hydraulic Radius | = | 2.121694 | feet |
| Discharge | = | 710 | cubic feet/sec |
| Velocity | = | 15.01791 | feet/sec |

# Table 5-11 - continued

## Channel Flow Calculation
## Side Channel

| | | | |
|---|---|---|---|
| Bed Slope | = | 0.08 | |
| Manning's N | = | 0.04 | |
| Bottom Width | = | 2 | feet |
| Channel Side Slope | = | 0.5 | |
| Flow Depth | = | 2.165701 | feet |
| Cross Sectional Area | = | 13.71192 | square feet |
| Wetted Perimeter | = | 11.68531 | feet |
| Hydraulic Radius | = | 1.173432 | feet |
| Discharge | = | 160 | cubic feet/sec |
| Velocity | = | 11.66868 | feet/sec |

# Table 5-11 - continued

## Channel Flow Calculation
## Sediment Pond Inlet

| | | | |
|---|---|---|---|
| Bed Slope | = | 0.06 | |
| Manning's N | = | 0.04 | |
| Bottom Width | = | 0.01 | feet |
| Channel Side Slope | = | 0.5 | |
| Flow Depth | = | 1.266117 | feet |
| Cross Sectional Area | = | 3.218768 | square feet |
| Wetted Perimeter | = | 5.67225 | feet |
| Hydraulic Radius | = | 0.5674588 | feet |
| Discharge | = | 20.1 | cubic feet/sec |
| Velocity | = | 6.244627 | feet/sec |

# Table 5-12
## Watershed Hydrograph - recreated from STORM®

| | |
|---|---|
| Project Title | Drainage Area No. 1 |
| Inflow into Structure | #1 |
| Structure Type | Null |

**Watershed Data for Watershed #1 (DA #1 Shown on Plate XX)**

| | | | |
|---|---|---|---|
| Curve Number | = | 95 | |
| Area | = | 0.2 | acres |
| Hydraulic Length | = | 320 | feet |
| Elevation Change | = | 8 | feet |
| Concentration Time | = | 0.03 | hours |
| Concentration Time Type | = | SCS Upland | |
| Unit Hydrograph Type | = | Disturbed | |
| Total Area | = | 0.2 | acres |

**Storm Data**

| | | | |
|---|---|---|---|
| Total Precipitation | = | 2.2 | inches |
| Storm Type | = | SCS 6 hr design storm | |
| Peak Discharge | = | 0.15 | cfs |
| Discharge Volume | = | 0.02 | ac-ft |

| Time (hr) | Rainfall (in) | Hydrograph (cfs) | Time (hr) | Rainfall (in) | Hydrograph (cfs) |
|---|---|---|---|---|---|
| 0.00 | 0.0000 | 0.000 | 0.20 | 0.028 | 0.000 |
| 0.40 | 0.0280 | 0.000 | 0.60 | 0.035 | 0.000 |
| 0.80 | 0.0420 | 0.001 | 1.00 | 0.042 | 0.003 |
| 1.20 | 0.0470 | 0.006 | 1.40 | 0.047 | 0.009 |
| 1.60 | 0.0650 | 0.015 | 1.80 | 0.308 | 0.023 |
| 2.00 | 0.0840 | 0.028 | 2.20 | 0.327 | 0.115 |
| 2.40 | 0.0327 | 0.145 | 2.60 | 0.208 | 0.106 |
| 2.80 | 0.0088 | 0.051 | 3.00 | 0.088 | 0.043 |
| 3.20 | 0.0700 | 0.036 | 3.40 | 0.070 | 0.035 |
| 3.60 | 0.0590 | 0.030 | 3.80 | 0.048 | 0.025 |
| 4.00 | 0.0480 | 0.024 | 4.20 | 0.043 | 0.022 |
| 4.40 | 0.0430 | 0.022 | 4.60 | 0.039 | 0.020 |
| 4.80 | 0.0350 | 0.018 | 5.00 | 0.035 | 0.018 |
| 5.20 | 0.0320 | 0.016 | 5.40 | 0.032 | 0.016 |
| 5.60 | 0.0330 | 0.017 | 5.80 | 0.035 | 0.018 |
| 6.00 | 0.0350 | 0.018 | 6.20 | 0.000 | 0.003 |
| 6.40 | 0.0000 | 0.000 | | | |

# Table 5-12 - continued
## Watershed Hydrograph - recreated from STORM®

| | |
|---|---|
| Project Title | Drainage Area No. 2 |
| Inflow into Structure | #1 |
| Structure Type | Null |

**Watershed Data for Watershed #2**

| | | | |
|---|---|---|---|
| Curve Number | = | 73 | |
| Area | = | 0.2 | acres |
| Hydraulic Length | = | 140 | feet |
| Elevation Change | = | 1 | feet |
| Concentration Time | = | 0.02 | hours |
| Concentration Time Type | = | SCS Upland | |
| Unit Hydrograph Type | = | Disturbed | |
| Total Area | = | 0.2 | acres |

**Storm Data**

| | | | |
|---|---|---|---|
| Total Precipitation | = | 2.2 | inches |
| Storm Type | = | SCS 6 hr design storm | |
| Peak Discharge | = | 0.2 | cfs |
| Discharge Volume | = | 0.03 | ac-ft |

| Time (hr) | Rainfall (in) | Hydrograph (cfs) | Time (hr) | Rainfall (in) | Hydrograph (cfs) |
|---|---|---|---|---|---|
| 0.00 | 0.0000 | 0.000 | 0.20 | 0.028 | 0.000 |
| 0.40 | 0.0280 | 0.001 | 0.60 | 0.035 | 0.005 |
| 0.80 | 0.0420 | 0.011 | 1.00 | 0.042 | 0.015 |
| 1.20 | 0.0470 | 0.020 | 1.40 | 0.047 | 0.022 |
| 1.60 | 0.0650 | 0.032 | 1.80 | 0.308 | 0.044 |
| 2.00 | 0.0840 | 0.048 | 2.20 | 0.327 | 0.176 |
| 2.40 | 0.0327 | 0.204 | 2.60 | 0.208 | 0.143 |
| 2.80 | 0.0088 | 0.067 | 3.00 | 0.088 | 0.056 |
| 3.20 | 0.0700 | 0.047 | 3.40 | 0.070 | 0.045 |
| 3.60 | 0.0590 | 0.039 | 3.80 | 0.048 | 0.032 |
| 4.00 | 0.0480 | 0.031 | 4.20 | 0.043 | 0.028 |
| 4.40 | 0.0430 | 0.028 | 4.60 | 0.039 | 0.026 |
| 4.80 | 0.0350 | 0.023 | 5.00 | 0.035 | 0.023 |
| 5.20 | 0.0320 | 0.021 | 5.40 | 0.032 | 0.020 |
| 5.60 | 0.0330 | 0.021 | 5.80 | 0.035 | 0.022 |
| 6.00 | 0.0350 | 0.023 | 6.20 | 0.000 | 0.003 |
| 6.40 | 0.0000 | 0.000 | | | |

# Table 5-12 - continued
## Watershed Hydrograph - recreated from STORM®

| | |
|---|---|
| Project Title | Drainage Area No. 3 |
| Inflow into Structure | #1 |
| Structure Type | Null |

**Watershed Data for Watershed #1**

| | | | |
|---|---|---|---|
| Curve Number | = | 77 | |
| Area | = | 1.6 | acres |
| Hydraulic Length | = | 513 | feet |
| Elevation Change | = | 52 | feet |
| Concentration Time | = | 0.06 | hours |
| Concentration Time Type | = | SCS Upland | |
| Unit Hydrograph Type | = | Forrested | |
| Total Area | = | 1.6 | acres |

**Storm Data**

| | | | |
|---|---|---|---|
| Total Precipitation | = | 2.2 | inches |
| Storm Type | = | SCS 6 hr design storm | |
| Peak Discharge | = | 0.31 | cfs |
| Discharge Volume | = | 0.07 | ac-ft |

| Time (hr) | Rainfall (in) | Hydrograph (cfs) | Time (hr) | Rainfall (in) | Hydrograph (cfs) |
|---|---|---|---|---|---|
| 0.00 | 0.0000 | 0.000 | 0.20 | 0.028 | 0.000 |
| 0.40 | 0.0280 | 0.000 | 0.60 | 0.035 | 0.000 |
| 0.80 | 0.0420 | 0.000 | 1.00 | 0.042 | 0.000 |
| 1.20 | 0.0470 | 0.000 | 1.40 | 0.047 | 0.000 |
| 1.60 | 0.0650 | 0.000 | 1.80 | 0.308 | 0.000 |
| 2.00 | 0.0840 | 0.000 | 2.20 | 0.327 | 0.047 |
| 2.40 | 0.0327 | 0.226 | 2.60 | 0.208 | 0.313 |
| 2.80 | 0.0088 | 0.255 | 3.00 | 0.088 | 0.244 |
| 3.20 | 0.0700 | 0.242 | 3.40 | 0.070 | 0.247 |
| 3.60 | 0.0590 | 0.241 | 3.80 | 0.048 | 0.225 |
| 4.00 | 0.0480 | 0.217 | 4.20 | 0.043 | 0.204 |
| 4.40 | 0.0430 | 0.194 | 4.60 | 0.039 | 0.180 |
| 4.80 | 0.0350 | 0.165 | 5.00 | 0.035 | 0.158 |
| 5.20 | 0.0320 | 0.149 | 5.40 | 0.032 | 0.143 |
| 5.60 | 0.0330 | 0.143 | 5.80 | 0.035 | 0.146 |
| 6.00 | 0.0350 | 0.147 | 6.20 | 0.000 | 0.091 |
| 6.40 | 0.0000 | 0.060 | 6.60 | 0.000 | 0.048 |
| 6.80 | 0.0000 | 0.037 | 7.00 | 0.000 | 0.028 |
| 7.20 | 0.0000 | 0.020 | 7.40 | 0.000 | 0.014 |
| 7.60 | 0.0000 | 0.009 | 7.80 | 0.000 | 0.004 |
| 8.00 | 0.0000 | 0.002 | 8.00 | 0.000 | 0.000 |
| 8.40 | 0.0000 | 0.000 | 8.20 | 0.000 | |

# Table 5-12 - continued
## Watershed Hydrograph - recreated from STORM®

| | |
|---|---|
| Project Title | Drainage Area No. 4 |
| Inflow into Structure | #1 |
| Structure Type | Null |

**Watershed Data for Watershed #1**

| | | | |
|---|---|---|---|
| Curve Number | = | 95 | |
| Area | = | 0.1 | acres |
| Hydraulic Length | = | 109 | feet |
| Elevation Change | = | 52 | feet |
| Concentration Time | = | 3.5 | hours |
| Concentration Time Type | = | SCS Upland | |
| Unit Hydrograph Type | = | Disturbed | |
| Total Area | = | 0.1 | acres |

**Storm Data**

| | | | |
|---|---|---|---|
| Total Precipitation | = | 2.2 | inches |
| Storm Type | = | SCS 6 hr design storm | |
| Peak Discharge | = | 0.007 | cfs |
| Discharge Volume | = | 0.02 | ac-ft |

| Time (hr) | Rainfall (in) | Hydrograph (cfs) | Time (hr) | Rainfall (in) | Hydrograph (cfs) |
|---|---|---|---|---|---|
| 0.00 | 0.0000 | 0.000 | 0.20 | 0.028 | 0.000 |
| 0.40 | 0.0280 | 0.000 | 0.60 | 0.035 | 0.000 |
| 0.80 | 0.0420 | 0.000 | 1.00 | 0.042 | 0.002 |
| 1.20 | 0.0470 | 0.003 | 1.40 | 0.047 | 0.004 |
| 1.60 | 0.0650 | 0.007 | 1.80 | 0.308 | 0.011 |
| 2.00 | 0.0840 | 0.013 | 2.20 | 0.327 | 0.056 |
| 2.40 | 0.0327 | 0.071 | 2.60 | 0.208 | 0.051 |
| 2.80 | 0.0088 | 0.024 | 3.00 | 0.088 | 0.021 |
| 3.20 | 0.0700 | 0.017 | 3.40 | 0.070 | 0.017 |
| 3.60 | 0.0590 | 0.015 | 3.80 | 0.048 | 0.012 |
| 4.00 | 0.0480 | 0.012 | 4.20 | 0.043 | 0.011 |
| 4.40 | 0.0430 | 0.010 | 4.60 | 0.039 | 0.010 |
| 4.80 | 0.0350 | 0.009 | 5.00 | 0.035 | 0.009 |
| 5.20 | 0.0320 | 0.008 | 5.40 | 0.032 | 0.008 |
| 5.60 | 0.0330 | 0.008 | 5.80 | 0.035 | 0.009 |
| 6.00 | 0.0350 | 0.009 | 6.20 | 0.000 | 0.001 |
| 6.40 | 0.0000 | 0.000 | | | |

# Table 5-13
# Circular Channel analysis & Design
## Solved with Manning's Equation

Open Channel - Uniform Flow

| | |
|---|---|
| Worksheet Name | Trail Mountain Pipe #1 |
| Comment | Trail Mountain Culvert #1 (inflows 1A, 1B, 1C) |

Solve for Actual Depth

**Given Input Data**

| | | |
|---|---|---|
| Diameter | 1.00 | feet |
| Slope | 0.06 | ft/ft |
| Manning's N | 0.025 | |
| discharge | 0.66 | cfs |

**Computed Results**

| | | |
|---|---|---|
| Depth | 0.26 | feet |
| Velocity | 4.12 | fps |
| Flow Area | 0.16 | sq. ft. |
| Critical Depth | 0.34 | ft |
| Critical Slope | 0.0208 | ft/ft |
| Percent Full | 25.77 | % |
| Full Capacity | 4.54 | cfs |
| QMAX @ .94D | 4.88 | cfs |

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# Table 5-13- continued
# Circular Channel analysis & Design
## Solved with Manning's Equation

Open Channel - Uniform Flow

| | |
|---|---|
| Worksheet Name | Trail Mountain Pipe #4 |
| Comment | Trail Mountain CMP #4 (inflows 1A, 1B, 1C, & 4) |

Solve for Actual Depth

**Given Input Data**

| | | |
|---|---|---|
| Diameter | 1.00 | feet |
| Slope | 0.067 | ft/ft |
| Manning's N | 0.025 | |
| discharge | 0.73 | cfs |

**Computed Results**

| | | |
|---|---|---|
| Depth | 0.26 | feet |
| Velocity | 4.41 | fps |
| Flow Area | 0.17 | sq. ft. |
| Critical Depth | 0.36 | ft |
| Critical Slope | 0.0209 | ft/ft |
| Percent Full | 26.37 | % |
| Full Capacity | 4.8 | cfs |
| QMAX @ .94D | 5.16 | cfs |

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# Table 5-13 - continued
## Circular Channel analysis & Design
### Solved with Manning's Equation

Open Channel - Uniform Flow

Worksheet Name Trail Mountain Pipe #5
Comment Trail Mountain Temporary Pipe #5

Solve for Actual Depth

**Given Input Data**

| | | |
|---|---|---|
| Diameter | 0.50 | feet |
| Slope | 0.058 | ft/ft |
| Manning's N | 0.016 | |
| discharge | 0.41 | cfs |

**Computed Results**

| | | |
|---|---|---|
| Depth | 0.21 | feet |
| Velocity | 5.19 | fps |
| Flow Area | 0.08 | sq. ft. |
| Critical Depth | 0.33 | ft |
| Critical Slope | 0.014 | ft/ft |
| Percent Full | 42.33 | % |
| Full Capacity | 1.1 | cfs |
| QMAX @ .94D | 1.18 | cfs |

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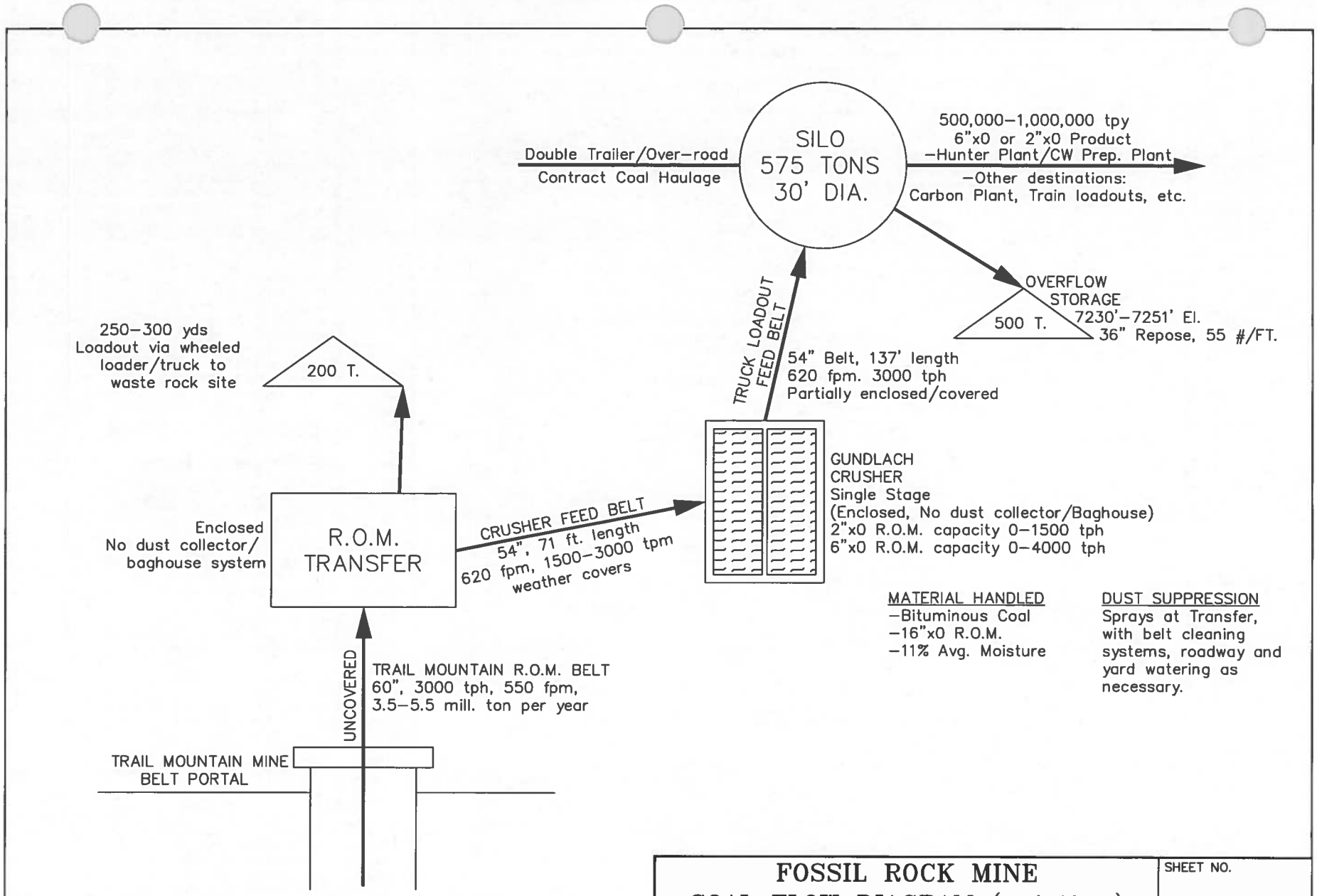
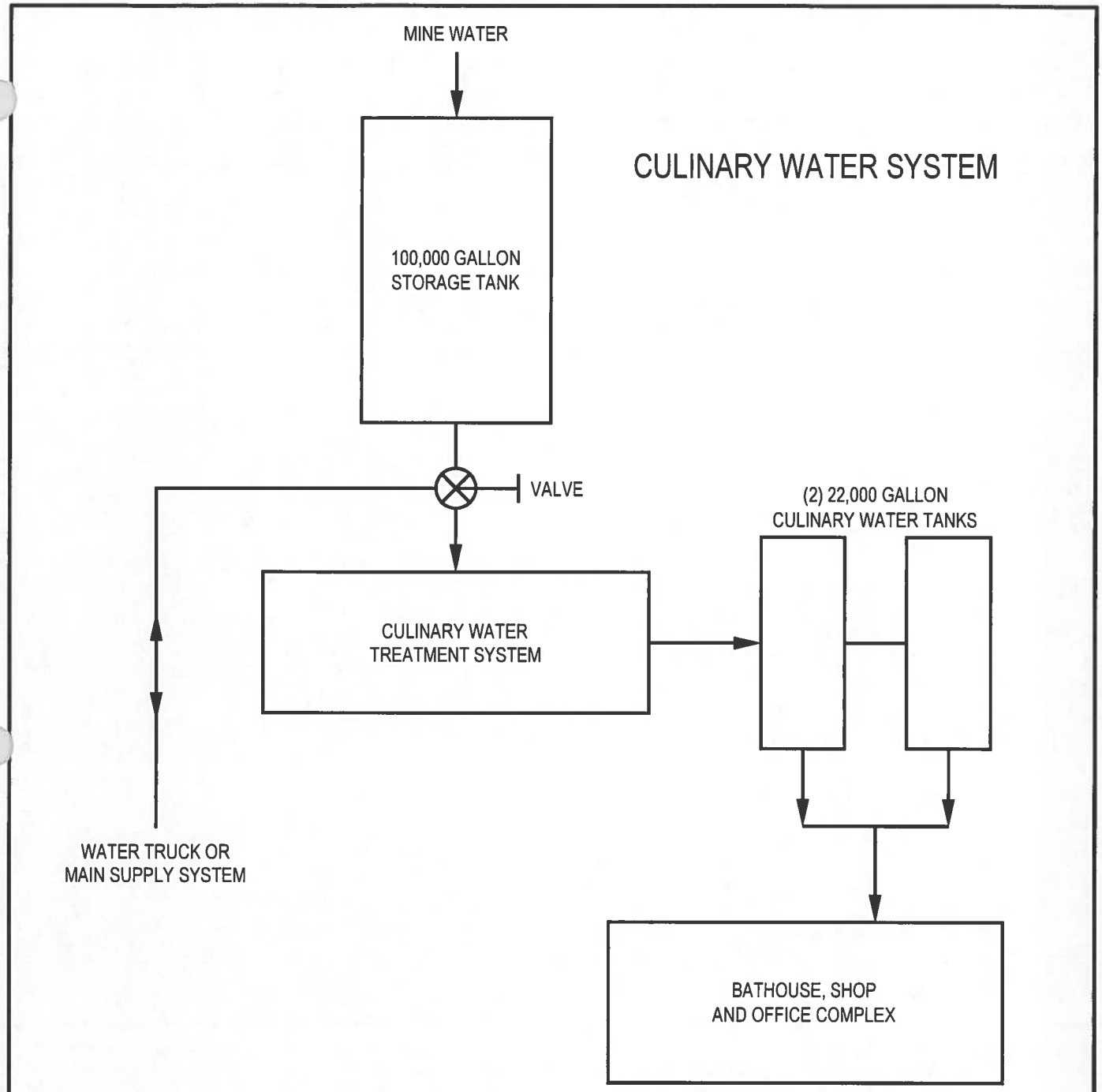


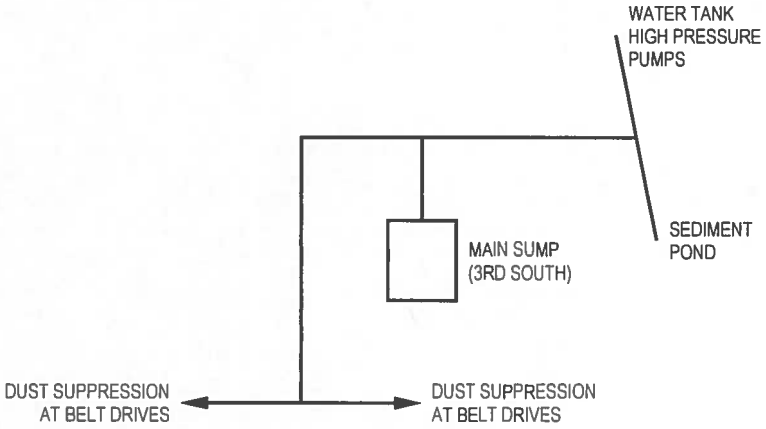

# FOSSIL ROCK MINE
# COAL FLOW DIAGRAM (existing)

| | | | |
|---|---|---|---|
| SCALE: NONE | DATE: 1/24/2018 | DRAWN BY: ENERGY WEST | SHEET NO. |
| ENGINEER: STOVER | CHECKED BY: J.E.S. | PERMIT: C/015/0009 | FIGURE 5-1 |
| FILE NAME: C:\A-D-Drive\WP60\Fossil Rock\Permit Applicaton\Figures\Chapter 5\Figure 5-1 5-1a Coal | | | |

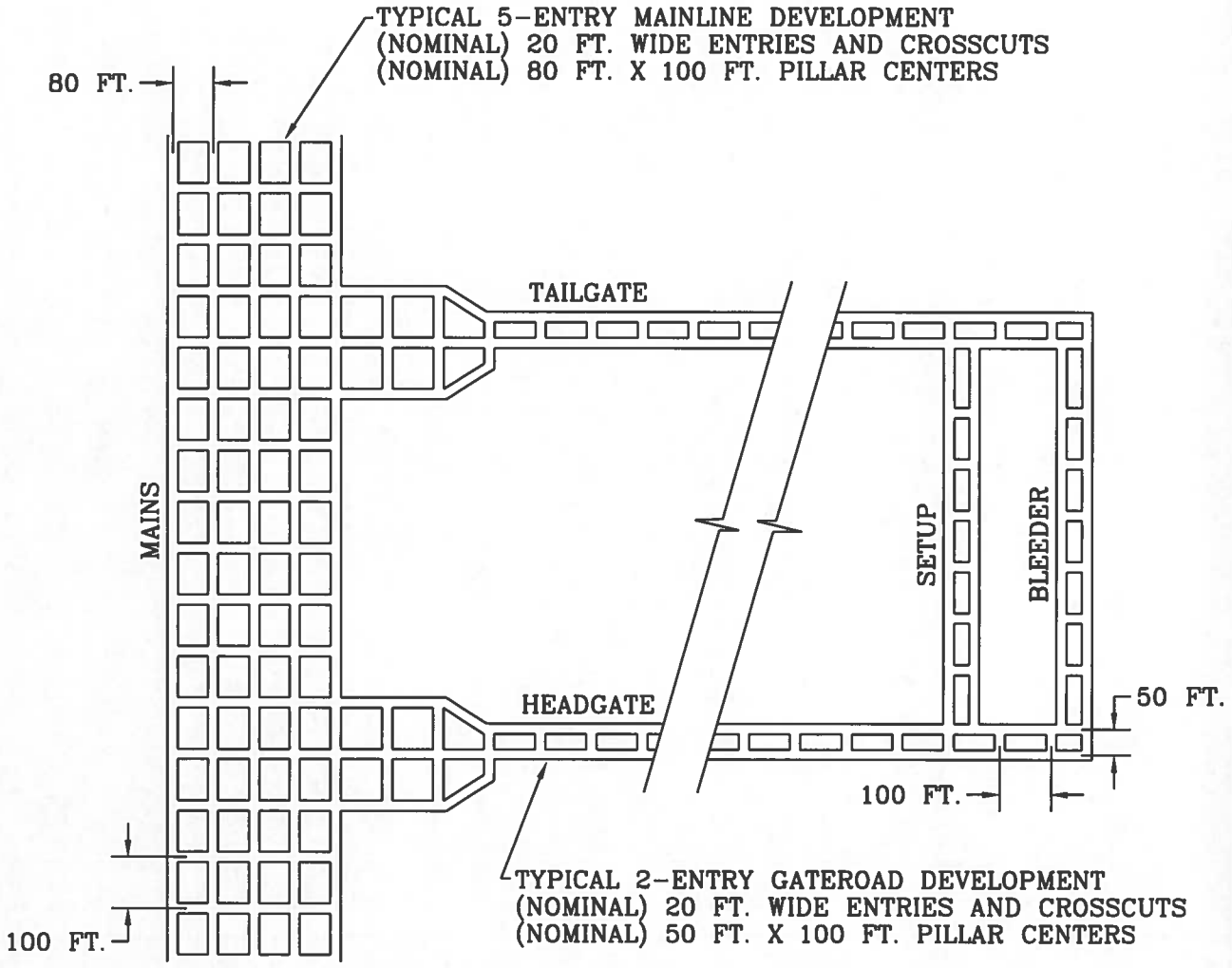



| FOSSIL ROCK MINE<br>CULINARY WATER SYSTEM | | | SHEET NO. |
|---|---|---|---|
| SCALE: NONE | DATE: 10/23/2017 | DRAWN BY: ENERGY WEST | FIGURE 5-2 |
| ENGINEER: STOVER | CHECKED BY: J.E.S. | PERMIT: C/015/0009 | |
| FILE NAME: C:\A-D-Drive\WP60\Fossil Rock\Permit Applicaton\Figures\Chapter 5\FIGURE 5-2 Culinary | | | |

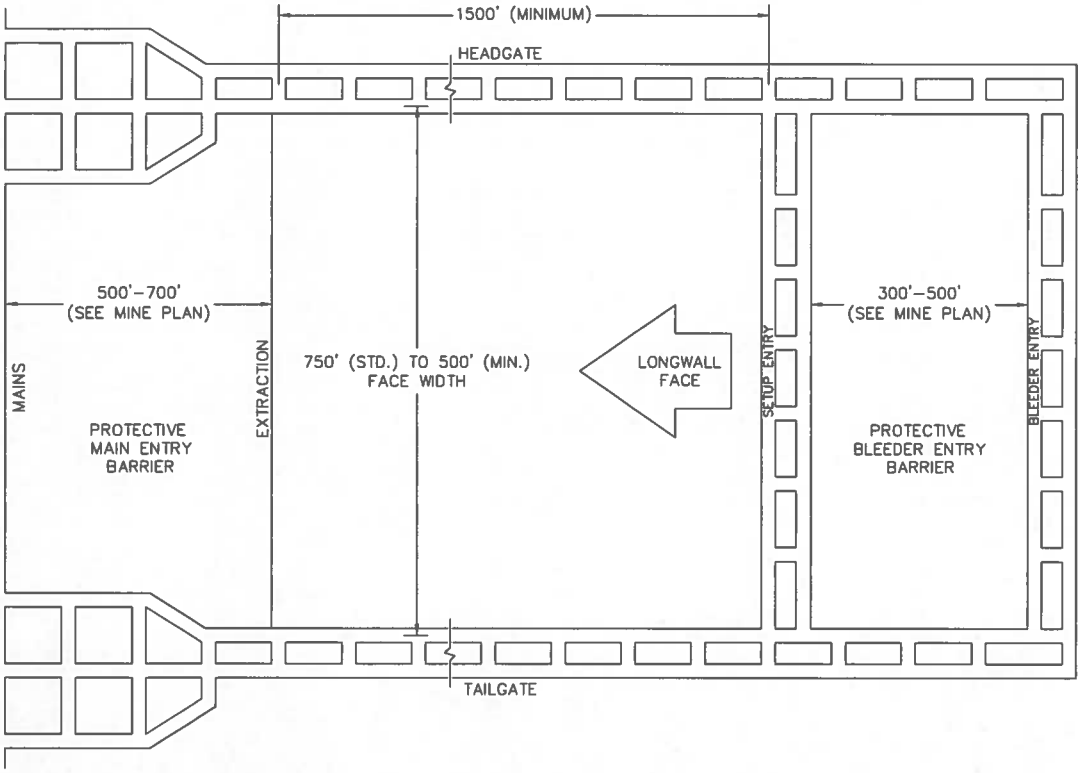
# TYPICAL UNDERGROUND WATER SYSTEM



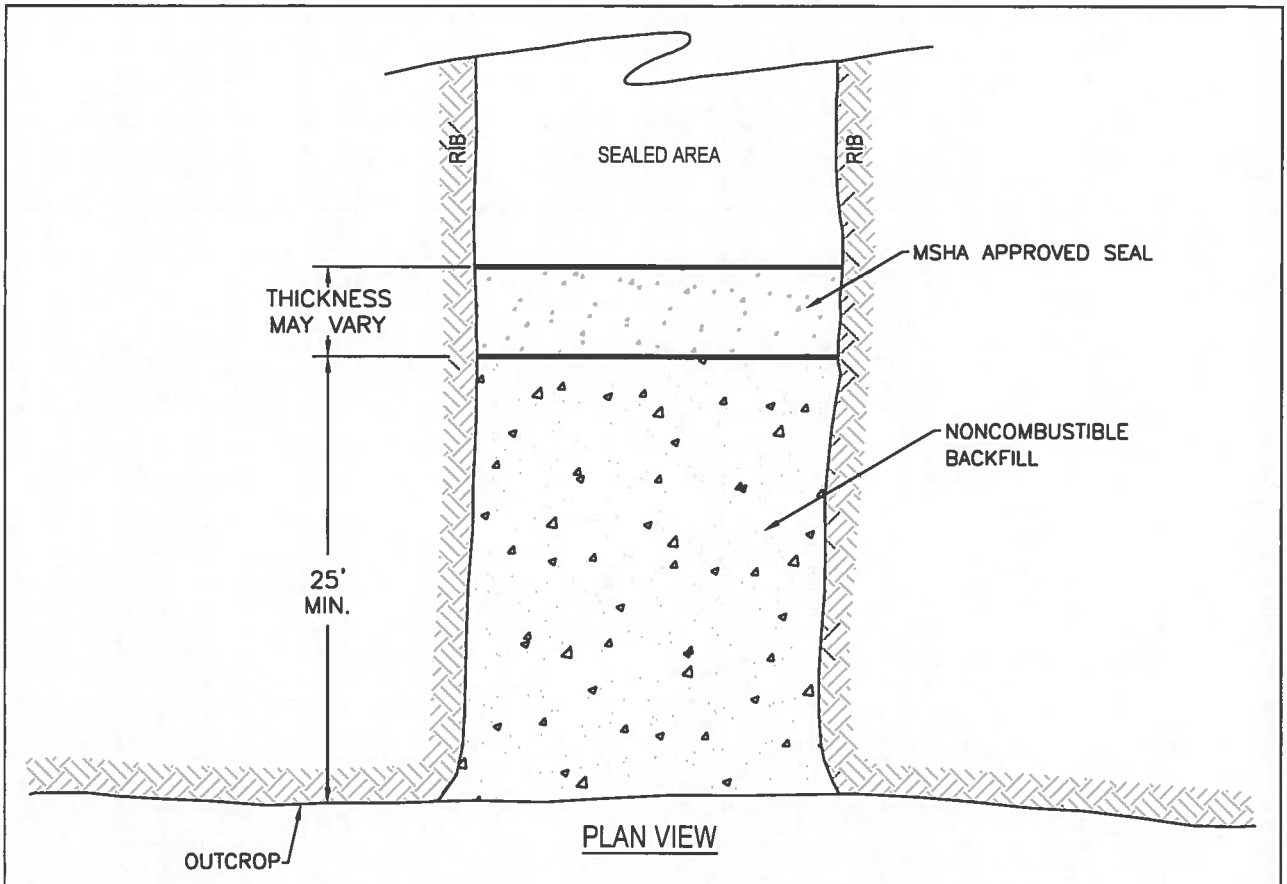

| FOSSIL ROCK MINE<br>TYP. UNDERGROUND WATER SYSTEM | | | SHEET NO. |
|---|---|---|---|
| SCALE: NONE | DATE: 10/23/2017 | DRAWN BY: ENERGY WEST | FIGURE 5-3 |
| ENGINEER: STOVER | CHECKED BY: J.E.S. | PERMIT: C/015/0009 | |
| FILE NAME: C:\A-D-Drive\WP60\Fossil Rock\Permit Applicaton\Figures\Chapter 5\FIGURE 5-3 Undergro | | | |



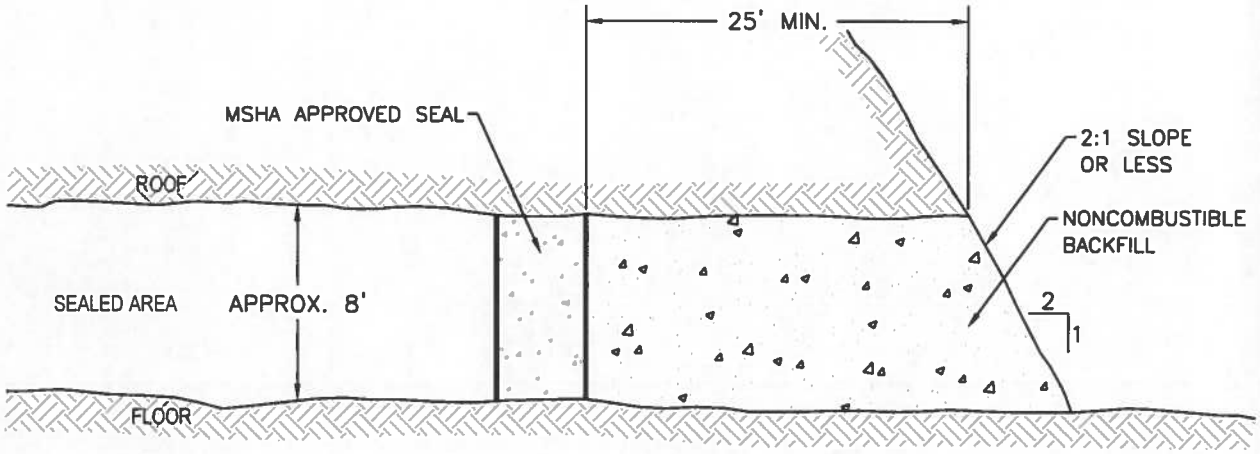

| FOSSIL ROCK MINE | | | SHEET NO. |
|---|---|---|---|
| TYP. MAIN ENTRY AND PANEL DEVELOPMENT | | | |
| SCALE: NONE | DATE: 11/20/2017 | DRAWN BY: ENERGY WEST | FIGURE 5-4 |
| ENGINEER: STOVER | CHECKED BY: J.E.S. | PERMIT: C/015/0009 | |
| FILE NAME: C:\A-D-Drive\WP60\Fossil Rock\Permit Applicaton\Figures\Chapter 5\FIGURE 5-4 Typical M | | | |




| FOSSIL ROCK MINE<br>TYPICAL LONGWALL RETREAT PANEL | | | SHEET NO. |
|---|---|---|---|
| SCALE: NONE | DATE: 11/20/2017 | DRAWN BY: ENERGY WEST | FIGURE 5–5 |
| ENGINEER: STOVER | CHECKED BY: J.E.S. | PERMIT: C/015/0009 | |
| FILE NAME: C:\A-D-Drive\WP60\Fossil Rock\Permit Applicaton\Figures\Chapter 5\FIGURE 5–5 Typical L | | | |




PLAN VIEW



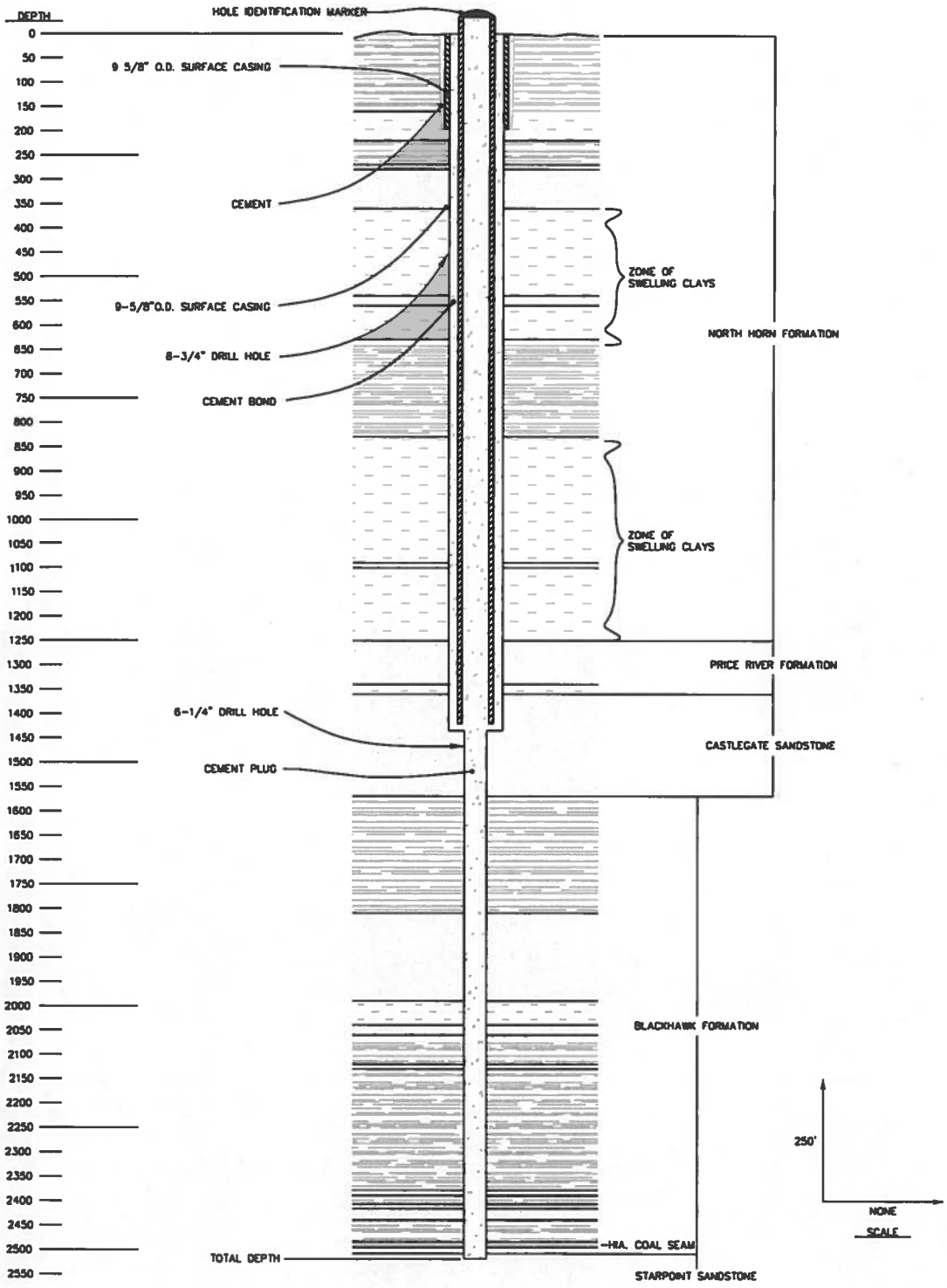

ELEVATION VIEW

NOTE:

SEAL DESIGN MAY VARY DEPENDING ON THE
MSHA REGULATIONS AT THE TIME OF SEALING

| FOSSIL ROCK MINE<br>TYPICAL PORTAL SEAL | | | SHEET NO. |
|---|---|---|---|
| SCALE: NONE | DATE: 10/23/2017 | DRAWN BY: ENERGY WEST | FIGURE 5-7 |
| ENGINEER: STOVER | CHECKED BY: J.E.S. | PERMIT: C/015/0009 | |
| FILE NAME: C:\A-D-Drive\WP60\Fossil Rock\Permit Applicaton\Figures\Chapter 5\FIGURE 5-7 Typical P | | | |

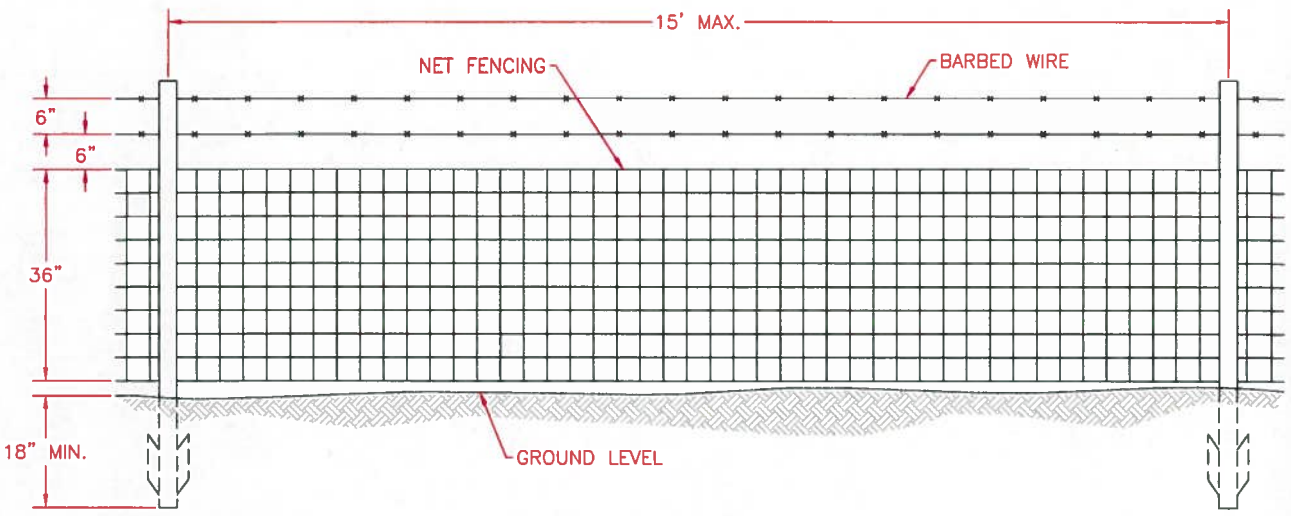
TYPICAL CROSS SECTION – TRAIL MOUNTAIN DRILL HOLE SEALING




LEGEND

- SANDSTONE
- MUDSTONE
- INTERBEDS
- COAL
- CEMENT

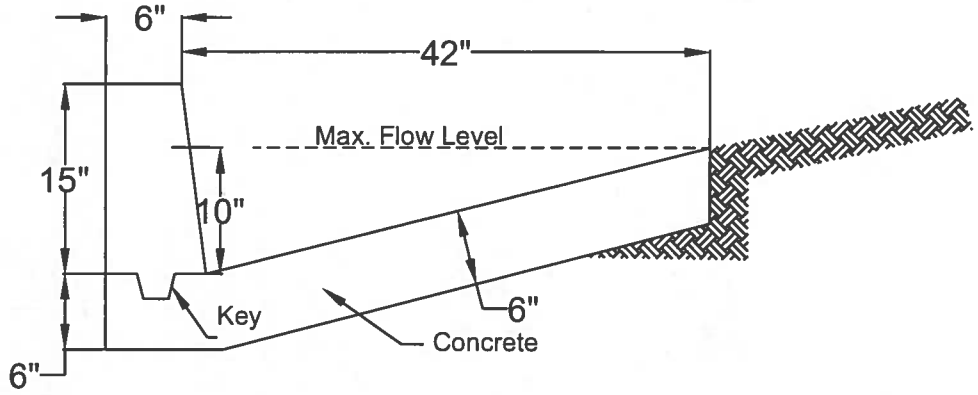
| FOSSIL ROCK MINE<br>TYPICAL DRILL HOLE SEAL | | | SHEET NO. |
|---|---|---|---|
| SCALE: NONE | DATE: 11/20/2017 | DRAWN BY: ENERGY WEST | FIGURE 5-8 |
| ENGINEER: STOVER | CHECKED BY: J.E.S. | PERMIT: C/015/0009 | |
| FILE NAME: C:\A-D-Drive\WP60\Fossil Rock\Permit Applicaton\Figures\Chapter 5\FIGURE 5-8 Typical D | | | |



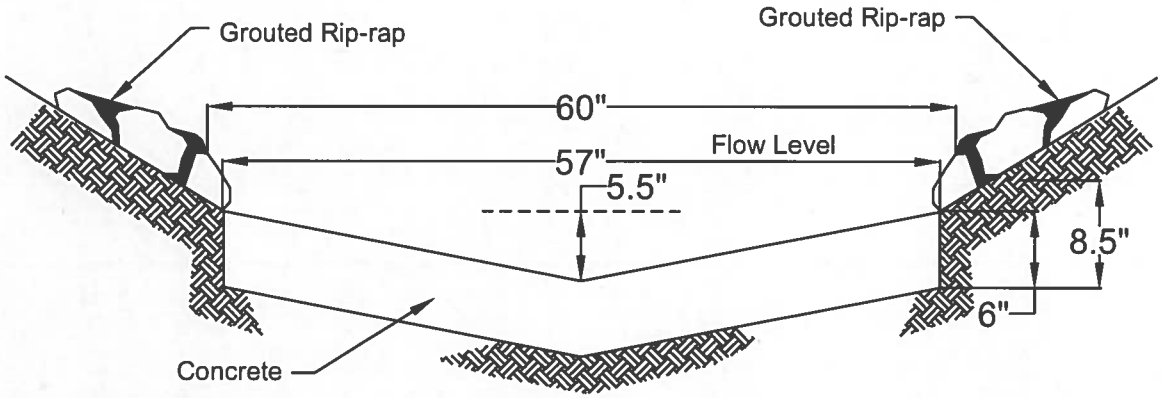

Mine Reclamation Fencing - Typical

| FOSSIL ROCK MINE<br>TYPICAL MINE RECLAMATION FENCE | | | SHEET NO. |
|---|---|---|---|
| SCALE: NONE | DATE: 10/23/2017 | DRAWN BY: ENERGY WEST | FIGURE 5-9 |
| ENGINEER: STOVER | CHECKED BY: J.E.S. | PERMIT: C/015/0009 | |
| FILE NAME: C:\A-D-Drive\WP60\Fossil Rock\Permit Applicaton\Figures\Chapter 5\FIGURE 5-9 Typical M | | | |

Figure 5-10
Typical Sections of Curb/Gutter Diversion
Trail Mountain Mine




Curb/Gutter
(Upper Section)
1" = 1'




Curb/Gutter
(Lower Section)
1" = 1'

# APPENDIX 5-1

# RECLAMATION BOND

| **Direct Costs** | | |
|---|---|---|
| Subtotal Demolition and Removal | $393,872.49 | |
| Subtotal Demolition and Removal - WRDS | $10,885.16 | |
| Subtotal Backfilling and Grading | $114.170.57 | |
| Subtotal Backfilling and Grading - WRDS | $180,218.10 | |
| Subtotal Revegetation | $91,033.80 | |
| Subtotal Revegetation - WRDS | $131,262.69 | |
| Subtotal Direct Costs | $921,442.81 | |
| **Indirect Costs** | | |
| Mob/Demob | $92,144.28 | 10.0% |
| Contingency | $46,072.14 | 5.0% |
| Engineering Redesign | $23,036.07 | 2.5% |
| Main Office Expense | $62,658.11 | 6.8% |
| Project Mainagement Fee | $23,036.07 | 2.5% |
| Subtotal Indirect Costs | $246,946.67 | 26.8% |
| **Total Cost** | **$1,168,389.48** | |
| Number of years | | 5 |
| Escalation to 2017 | | 0 |
| Escalation Dollars | $0.00 | |
| **Reclamation Cost Escalated (2021 Dollars)** | **$1,168,389.48** | |
| **Bond Amount (rounded to nearest $1000) (2021 Dollars** | **$1,168,000.00** | |
| Posted Bond 8/21/2018 | $1,168,000.00 | |
| Difference Between Cost Estimate and Bond | $0.00 | |
| Percent Over Bonded or (Under Bonded) | 0.00% | |

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| Demolition Cost Summary | | |
|---|---|---|
| Item # | Description | Cost |
| 1 | Substation, Powerline, & Poles | $ 4,459.38 |
| 2 | Shop, Bathhouse | $ 21,587.22 |
| 3 | Water Treatment Plant, Tanks, Fuel | $ 5,232.74 |
| 4 | Sewer System | $ 4,653.24 |
| 5 | Miscellaneous Concrete | $ 25,233.10 |
| 6 | Concrete Pads | $ 32,925.74 |
| 7 | Waste and Salt Bunkers | $ 3,461.68 |
| 8 | Truck Loadout and Silo | $ 26,738.46 |
| 9 | Chutes and Trusses | $ 24,227.92 |
| 10 | Mine Fan | $ 33,373.98 |
| 11 | Storage Shed | $ 3,965.40 |
| 12 | ROM Transfer Building | $ 34,062.88 |
| 13 | ROM Overland Conveyor | $ 24,523.54 |
| 14 | Loading Dock and Tank Farm | $ 9,215.32 |
| 15 | Coal Pile Retaining Wall | $ 4,231.44 |
| 16 | Sediment Pond | $ 1,185.56 |
| 17 | Replaced by Sheet 19 | $ - |
| 18 | Culvert Removal | $ 34,296.84 |
| 19 | Portal Framework and Liners | $ 53,223.26 |
| 20 | Gunite/Shotcrete Removal | $ 4,766.74 |
| 21 | Rock Dust Tank | $ 1,376.92 |
| 22 | Fence Removal | $ 3,950.62 |
| 23 | Asphalt Removal | $ 37,180.51 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | Total | $ 393,872.49 |

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| 01 - Substation, Powerline, & Poles | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Substation, Powerline, & Poles | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| **Steel Demolition Cost** | | | | | | 15 | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 4.0 | hr | $ 140.38 | $ 561.52 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 4.0 | hr | $ 21.75 | $ 87.00 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 4.0 | hr | $ 82.25 | $ 329.00 |
| | Common Building Labor | | CLAB | 2 | | | 4.0 | hr | $ 60.00 | $ 480.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 4.0 | hr | $ 21.30 | $ 85.20 |
| **Concrete Demolition Cost (Ref. 2,3)** | | | | | 98.8 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 2.0 | hr | $ 140.38 | $ 280.76 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 2.0 | hr | $ 47.03 | $ 94.06 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 2.0 | hr | $ 81.00 | $ 162.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 2.0 | hr | $ 82.25 | $ 164.50 |
| | Common Building Labor | | CLAB | 2 | | | 2.0 | hr | $ 60.00 | $ 240.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 2.0 | hr | $ 61.00 | $ 122.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 2.0 | hr | $ 21.30 | $ 42.60 |
| **Transportation Costs** | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 4.0 | hr | $ 80.33 | $ 321.32 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 4.0 | hr | $ 68.70 | $ 274.80 |
| **Miscellaneous** | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 tons = 8 CY | | | | 15 | | ton | | |
| | | | | | 10 | | | cy | $ 14.00 | $ 140.00 |
| Demolished Concrete Handling (Ref. 6) | | | | | 128.44 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 2.0 | hr | $ 245.88 | $ 491.76 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 2.0 | hr | $ 81.00 | $ 162.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 6.0 | hr | $ 12.00 | $ 72.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 6.0 | hr | $ 1.76 | $ 10.56 |
| **Total** | | | | | | | | | | $ 4,459.36 |

**Reference Information**
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 01)
(Concrete Ref - 01)

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| 02 - Office, Shop, Bathhouse, Warehouse | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Shop, Bathhouse | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | 30 | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 16.0 | hr | $ 140.38 | $ 2,246.08 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 16.0 | hr | $ 21.75 | $ 348.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 16.0 | hr | $ 82.25 | $ 1,316.00 |
| | Common Building Labor | | CLAB | 3 | | | 16.0 | hr | $ 60.00 | $ 2,880.00 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 16.0 | hr | $ 81.00 | $ 1,296.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 16.0 | hr | $ 21.30 | $ 340.80 |
| Concrete Demolition Cost | | | | | 259 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 10.0 | hr | $ 140.38 | $ 1,403.80 |
| | Foreman Average, Outside | | Foreman | 1 | | | 10.0 | hr | $ 82.25 | $ 822.50 |
| | Common Building Labor | | CLAB | 2 | | | 10.0 | hr | $ 60.00 | $ 1,200.00 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 10.0 | hr | $ 81.00 | $ 810.00 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 10.0 | hr | $ 47.03 | $ 470.30 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 10.0 | hr | $ 21.75 | $ 217.50 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 10.0 | hr | $ 81.00 | $ 810.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 10.0 | hr | $ 81.00 | $ 810.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 4 | | | | ea | $ 4.10 | $ 16.40 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 10.0 | hr | $ 21.30 | $ 213.00 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 2 | | | 16.0 | hr | $ 80.33 | $ 2,570.56 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 16.0 | hr | $ 68.70 | $ 2,198.40 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 200 | 12 tons = 8 CY | | | | 30 | | ton | | |
| | | | | | 20.0 | | | cy | $ 14.00 | $ 280.00 |
| Demolished Concrete Handling (Ref. 3) | | | | | 336.7 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 4.0 | hr | $ 245.88 | $ 983.52 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 16.0 | hr | $ 12.00 | $ 192.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 16.0 | hr | $ 1.76 | $ 28.16 |
| Total | | | | | | | | | | $ 21,587.22 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 02)
(Concrete Ref - 02)

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| 03 - Water Treatment Plant, Water StorageTanks and Fuel Storage Facility | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Water Treatment Plant, Tanks, Fuel | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| **Steel Demolition Cost** | | | | | | 10 | | | | |
| | 01 54 33 20 0300 | Aerial Lift, 60 feet | | 1 | | | 4.0 | hr | $ 140.38 | $ 561.52 |
| | 01 54 33 60 2500 | Crane - 25 ton | | 1 | | | 4.0 | hr | $ 84.23 | $ 336.92 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 1 | | | 4.0 | hr | $ 84.25 | $ 337.00 |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 4.0 | hr | $ 140.38 | $ 561.52 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 4.0 | hr | $ 21.75 | $ 87.00 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 4.0 | hr | $ 82.25 | $ 329.00 |
| | Common Building Labor | | CLAB | 2 | | | 4.0 | hr | $ 60.00 | $ 480.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 4.0 | hr | $ 21.30 | $ 85.20 |
| **Concrete Demolition Cost** | (Refer to Sheet 05 - Concrete Pads) | | | | | | | | | |
| **Transportation Costs (Ref. 5)** | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 2.0 | hr | $ 80.33 | $ 160.66 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 2.0 | hr | $ 68.70 | $ 274.80 |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 4.0 | hr | $ 44.78 | $ 179.12 |
| | 01 54 33 40 6600 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 4.0 | hr | $ 15.12 | $ 60.48 |
| **Miscellaneous** | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 tons = 8 CY | | | | 10 | | ton | | |
| | | | | | 6.64 | | | cy | $ 14.00 | $ 92.96 |
| | 01 54 33 20 4810 | Loader - 6 CY | | 1 | | | 4.0 | hr | $ 245.88 | $ 983.52 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 4.0 | hr | $ 12.00 | $ 48.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 4.0 | hr | $ 1.76 | $ 7.04 |
| **Total** | | | | | | | | | | $ 5,232.74 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 03)
(Concrete Ref - 05)

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| 04 - Sewer Collection and Pumping System | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Sewer System | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| **Steel Demolition Cost** | | | | | | 15 | | | | |
| | 01 54 33 60 2500 | Crane - 25 ton | | 1 | | | 4.0 | hr | $ 84.23 | $ 336.92 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 1 | | | 4.0 | hr | $ 84.25 | $ 337.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 4.0 | hr | $ 82.25 | $ 329.00 |
| | Common Building Labor | | CLAB | 2 | | | 4.0 | hr | $ 60.00 | $ 480.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 4.0 | hr | $ 21.30 | $ 85.20 |
| **Concrete Demolition Cost (Ref. 2, 3)** | | | | | 30.4 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 2.0 | hr | $ 140.38 | $ 280.76 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 2.0 | hr | $ 47.03 | $ 94.06 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 2.0 | hr | $ 81.00 | $ 162.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 2.0 | hr | $ 82.25 | $ 164.50 |
| | Common Building Labor | | CLAB | 2 | | | 2.0 | hr | $ 60.00 | $ 240.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 2.0 | hr | $ 61.00 | $ 122.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 2.0 | hr | $ 21.30 | $ 21.30 |
| **Transportation Costs (Ref. 5)** | | | | 1 | | | | | | |
| | 01 54 33 40 6500 | Dump Truck - 3 axle, 12 CY | | 1 | | | 4.0 | hr | $ 80.33 | $ 321.32 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 4.0 | hr | $ 68.70 | $ 274.80 |
| **Miscellaneous** | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 tons = 8 YD | | | | | | ton | | |
| Demolished Concrete Handling (Ref. 6) | | | | | 39.52 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 4.0 | hr | $ 245.88 | $ 983.52 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 6.0 | hr | $ 12.00 | $ 72.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 6.0 | hr | $ 1.76 | $ 10.56 |
| | | | | | | | | | | |
| **Total** | | | | | | | | | | $ 4,663.24 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift, (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 04)
(Concrete Ref - 04)

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| 05 - Miscellaneous Concrete | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Miscellaneous Concrete | Means Reference Number (2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity (number) | Volume (cy) | Weight (tons) | Time (hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | | | | | |
| Concrete Demolition Cost (Ref. 2,3) | | | | | 596.3 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 40.0 | hr | $ 140.38 | $ 5,615.20 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 40.0 | hr | $ 21.75 | $ 870.00 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 40.0 | hr | $ 81.00 | $ 3,240.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 40.0 | hr | $ 82.25 | $ 3,290.00 |
| | Common Building Labor | | CLAB | 1 | | | 40.0 | hr | $ 60.00 | $ 2,400.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 40.0 | hr | $ 61.00 | $ 2,440.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 40.0 | hr | $ 21.30 | $ 852.00 |
| Transportation Costs (Ref. 5) | | | | 1 | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 40.0 | hr | $ 80.33 | $ 3,213.20 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 40.0 | hr | $ 68.70 | $ 2,748.00 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 16 0200 | | | | | 0 | | ton | | |
| Demolished Concrete Handling (Ref. 6) | | | | | 775.19 | | | | | |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 40.0 | hr | $ 12.00 | $ 480.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 40.0 | hr | $ 1.76 | $ 70.40 |
| Total | | | | | | | | | | $ 25,233.10 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet

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| 06 - Pumphouse, Tanks, and Concrete Pads | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Concrete Pads | Means Reference Number (2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity (number) | Volume (cy) | Weight (tons) | Time (hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | 55 | | | | |
| | 01 54 33 40 0190 | Aerial Lift, 60 feet | | 1 | | | 40 | hr | $ 60.71 | $ 2,428.40 |
| | 01 54 33 60 2500 | Crane - 25 ton | | 1 | | | 40 | hr | $ 84.23 | $ 3,369.20 |
| | Equipment Operator, Crane or Shovel | | | 1 | | | 40 | hr | $ 84.25 | $ 3,370.00 |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 4 | hr | $ 140.38 | $ 561.52 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 4 | hr | $ 21.75 | $ 87.00 |
| | Equipment Operator, Medium Equipment | | | 1 | | | 4 | hr | $ 81.00 | $ 324.00 |
| | Foreman Average, Outside | | | 1 | | | 40 | hr | $ 82.25 | $ 3,290.00 |
| | Common Building Labor | CLAB | | 3 | | | 40 | hr | $ 60.00 | $ 7,200.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 40 | hr | $ 21.30 | $ 852.00 |
| Concrete Demolition Cost (Ref. 2,3) | | | | | 151.3 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 8.0 | hr | $ 140.38 | $ 1,123.04 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 8.0 | hr | $ 47.03 | $ 376.24 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 8.0 | hr | $ 81.00 | $ 648.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 8.0 | hr | $ 82.25 | $ 658.00 |
| | Common Building Labor | CLAB | CLAB | 2 | | | 8.0 | hr | $ 60.00 | $ 960.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 8.0 | hr | $ 61.00 | $ 488.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 8.0 | hr | $ 21.30 | $ 170.40 |
| Transportation Costs (Ref. 5) | | | | 1 | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 6.0 | hr | $ 80.33 | $ 481.98 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 15.0 | hr | $ 68.70 | $ 2,061.00 |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 24.0 | hr | $ 44.78 | $ 1,074.72 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 24.0 | hr | $ 15.12 | 362.88 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 55 | | ton | | |
| | | | | 36.67 | | | | cy | $ 14.00 | $ 513.38 |
| Demolished Concrete Handling (ref. 6) | | | | | 198.69 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 6.0 | hr | $ 245.88 | $ 1,475.28 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 6.0 | hr | $ 81.00 | $ 486.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 40.0 | hr | $ 12.00 | $ 480.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 40.0 | hr | $ 1.76 | $ 70.40 |
| Total | | | | | | | | | | $ 32,925.74 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift, (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 06)
(Concrete Ref - 06)

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| 07 - Non Coal Waste and Salt Bunkers | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Waste and Salt Bunkers | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| **Steel Demolition Cost** | | | | | | 30 | | | | |
| | 01 54 33 60 2500 | Crane - 25 ton | | 1 | | | 2.0 | hr | $ 84.23 | $ 168.46 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 1 | | | 2.0 | hr | $ 84.25 | $ 168.50 |
| | Foreman Average, Outside | | Foreman | 1 | | | 2.0 | hr | $ 82.25 | $ 164.50 |
| | Common Building Labor | | CLAB | 2 | | | 2.0 | hr | $ 60.00 | $ 240.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 2.0 | hr | $ 21.30 | $ 42.60 |
| **Concrete Demolition Cost (Ref. 2,3)** | | | | | 16.7 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 2.0 | hr | $ 140.38 | $ 280.76 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 2.0 | hr | $ 47.03 | $ 94.06 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 2.0 | hr | $ 81.00 | $ 162.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 2.0 | hr | $ 82.25 | $ 164.50 |
| | Common Building Labor | | CLAB | 2 | | | 2.0 | hr | $ 60.00 | $ 240.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 2.0 | hr | $ 61.00 | $ 122.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 2.0 | hr | $ 21.30 | $ 42.60 |
| **Transportation Costs (Ref. 5)** | | | | 1 | | | | | | $ - |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | | | | 4.0 | hr | $ 80.33 | $ 321.32 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 4.0 | hr | $ 68.70 | $ 274.80 |
| **Miscellaneous** | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 16 0200 | 12 ton = 8 CY | | | | 30 | | ton | | |
| | | | | 20 | | | | cy | $ 14.00 | $ 280.00 |
| Demolished Concrete Handling (Ref. 6) | | | | | 21.71 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 2.0 | hr | $ 245.88 | $ 491.76 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 2.0 | hr | $ 81.00 | $ 162.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 2.0 | hr | $ 12.00 | $ 24.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 2.0 | hr | $ 1.76 | $ 3.52 |
| **Total** | | | | | | | | | | $ 3,461.68 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift, (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill, Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip,
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 07)
(Concrete Ref - 07)

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| 08 - Truck Loadout and Silo | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Truck Loadout and Silo | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | 30 | | | | |
| | 01 54 33 60 2500 | Crane - 25 ton | | 1 | | | 40.0 | hr | $ 84.23 | $ 3,369.20 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 1 | | | 40.0 | hr | $ 84.25 | $ 3,370.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 40.0 | hr | $ 82.25 | $ 3,290.00 |
| | Common Building Labor | | CLAB | 3 | | | 40.0 | hr | $ 60.00 | $ 7,200.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 2 | | | 40.0 | hr | $ 21.30 | $ 1,704.00 |
| Concrete Demolition Cost (Ref. 2,3) | | | | | 22.8 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 4.0 | hr | $ 140.38 | $ 561.52 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 4.0 | hr | $ 47.03 | $ 188.12 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 4.0 | hr | $ 82.25 | $ 329.00 |
| | Common Building Labor | | CLAB | 2 | | | 4.0 | hr | $ 60.00 | $ 480.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 4.0 | hr | $ 61.00 | $ 244.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 4.0 | hr | $ 21.30 | $ 85.20 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 40 6500 | Dump Truck - 3 axle, 12 CY | | 1 | | | 8.0 | hr | $ 80.33 | $ 642.64 |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 8.0 | hr | $ 44.78 | $ 358.24 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 16.0 | hr | $ 15.12 | $ 241.92 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 16.0 | hr | $ 68.70 | $ 2,198.40 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 30 | | ton | | |
| | | | | | 20 | | | cy | $ 14.00 | $ 280.00 |
| Demolished Concrete Handling (Ref. 6) | | | | | 29.64 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 4.0 | hr | $ 245.88 | $ 983.52 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 40.0 | hr | $ 12.00 | $ 480.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 40.0 | hr | $ 1.76 | $ 70.40 |
| Total | | | | | | | | | | $ 26,738.45 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 08)
(Concrete Ref - 08)

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| 09 - Chutes and Trusses from Crusher | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Chutes and Trusses | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| Steel Demolition Cost | | | | | | 30 | | | | |
| | 01 54 33 60 2500 | Crane - 25 ton | | 1 | | | 40.0 | hr | $ 84.23 | $ 3,369.20 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 1 | | | 40.0 | hr | $ 84.25 | $ 3,370.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 40.0 | hr | $ 82.25 | $ 3,290.00 |
| | Common Building Labor | | CLAB | 3 | | | 40.0 | hr | $ 60.00 | $ 7,200.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 2 | | | 40.0 | hr | $ 21.30 | $ 1,704.00 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 16.0 | hr | $ 44.78 | $ 716.48 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 16.0 | hr | $ 15.12 | $ 241.92 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 16.0 | hr | $ 68.70 | $ 2,198.40 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 30 | | ton | | |
| | | | | | 20 | | | cy | $ 14.00 | $ 280.00 |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 4.0 | hr | $ 245.88 | $ 983.52 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 40.0 | hr | $ 12.00 | $ 480.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 40.0 | hr | $ 1.76 | $ 70.40 |
| Total | | | | | | | | | | $ 24,227.92 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 09)

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| 10 - Mine Fan | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Mine Fan | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| **Steel Demolition Cost** | | | | | | 30 | | | | |
| | 01 54 33 60 2500 | Crane - 25 ton | | 1 | | | 40.0 | hr | $ 84.23 | $ 3,369.20 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 1 | | | 40.0 | hr | $ 84.25 | $ 3,370.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 40.0 | hr | $ 82.25 | $ 3,290.00 |
| | Common Building Labor | | CLAB | 3 | | | 40.0 | hr | $ 60.00 | $ 7,200.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 2 | | | 40.0 | hr | $ 21.30 | $ 1,704.00 |
| **Concrete Demolition Cost (Ref. 2,3)** | | | | | 158.7 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 16.0 | hr | $ 140.38 | $ 2,246.08 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 16.0 | hr | $ 47.03 | $ 752.48 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 16.0 | hr | $ 81.00 | $ 1,296.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 16.0 | hr | $ 82.25 | $ 1,316.00 |
| | Common Building Labor | | CLAB | 2 | | | 16.0 | hr | $ 60.00 | $ 1,920.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 16.0 | hr | $ 61.00 | $ 976.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 16.0 | hr | $ 21.30 | $ 340.80 |
| **Transportation Costs (Ref. 5)** | | | | | | | | | | |
| | 01 54 33 40 6500 | Dump Truck - 3 axle, 12 CY | | 1 | | | 8.0 | hr | $ 80.33 | $ 642.64 |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 8.0 | hr | $ 44.78 | $ 358.24 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 16.0 | hr | $ 15.12 | $ 241.92 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 16.0 | hr | $ 68.70 | $ 2,198.40 |
| **Miscellaneous** | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 30 | | ton | | |
| | | | | | 20 | | | cy | $ 14.00 | $ 280.00 |
| Demolished Concrete Handling (Ref. 6) | | | | | 206.31 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 4.0 | hr | $ 245.88 | $ 983.52 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 40.0 | hr | $ 12.00 | $ 480.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 40.0 | hr | $ 1.76 | $ 70.40 |
| **Total** | | | | | | | | | | $ 33,373.96 |

Reference Information

2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
4 - Added 5% for larger size compressor.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 10)
(Concrete Ref - 10)

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| 11 - Storage Shed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Storage Shed | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | 15 | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 4.0 | hr | $ 140.38 | $ 561.52 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 4.0 | hr | $ 21.75 | $ 87.00 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 4.0 | hr | $ 82.25 | $ 329.00 |
| | Common Building Labor | | CLAB | 2 | | | 4.0 | hr | $ 60.00 | $ 480.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 4.0 | hr | $ 21.30 | $ 85.20 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 4.0 | hr | $ 80.33 | $ 321.32 |
| | Truck Driver, Heavy | Truck Driver, Heavy | Drhv | 1 | | | 4.0 | hr | $ 68.70 | $ 274.80 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 15 | | ton | | |
| | | | | | 10 | | | | $14.00 | $ 140.00 |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 4.0 | hr | $ 245.88 | $ 983.52 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 4.0 | hr | $ 12.00 | $ 48.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 4.0 | hr | $ 1.76 | $ 7.04 |
| Total | | | | | | | | | | $ 3,965.40 |

Reference Information

2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 11)

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| 12 - ROM Transfer Building | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>ROM Transfer Building | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| Steel Demolition Cost | | | | | | 50 | | | | |
| | 01 54 33 60 2200 | Crane, 115 ton | | 1 | | | 40.0 | hr | $ 226.30 | $ 9,132.00 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 3 | | | 40.0 | hr | $ 84.25 | $ 10,110.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 40.0 | hr | $ 82.25 | $ 3,290.00 |
| | Common Building Labor | | CLAB | 1 | | | 40.0 | hr | $ 60.00 | $ 2,400.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 2 | | | 40.0 | hr | $ 21.30 | $ 1,704.00 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 16.0 | hr | $ 44.78 | $ 716.48 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 16.0 | hr | $ 15.12 | $ 241.92 |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 8.0 | hr | $ 80.33 | $ 642.64 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 16.0 | hr | $ 68.70 | $ 2,198.40 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 50 | | ton | | |
| | | | | | 33 | | | cy | $ 14.00 | $ 462.00 |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 8.0 | hr | $ 245.88 | $ 1,967.04 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 8.0 | hr | $ 81.00 | $ 648.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 40.0 | hr | $ 12.00 | $ 480.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 40.0 | hr | $ 1.76 | $ 70.40 |
| Total | | | | | | | | | | $ 34,062.88 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 12)

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| 13 - ROM Overland Tube Conveyor | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>ROM Overland Conveyor | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| **Steel Demolition Cost** | | | | | | 30 | | | | |
| | 01 54 33 60 2200 | Crane, 115 ton | | 1 | | | 28.0 | hr | $ 228.25 | $ 6,391.00 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 1 | | | 28.0 | hr | $ 84.25 | $ 2,359.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 28.0 | hr | $ 82.25 | $ 2,303.00 |
| | Common Building Labor | | CLAB | 1 | | | 28.0 | hr | $ 60.00 | $ 1,680.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 2 | | | 28.0 | hr | $ 21.30 | $ 1,192.80 |
| **Concrete Demolition Cost (Ref. 2,3)** | | | | | 88.5 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 8.0 | hr | $ 140.38 | $ 1,123.04 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 8.0 | hr | $ 47.03 | $ 376.24 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 8.0 | hr | $ 81.00 | $ 648.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 8.0 | hr | $ 82.25 | $ 658.00 |
| | Common Building Labor | | CLAB | 2 | | | 8.0 | hr | $ 60.00 | $ 960.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 16.0 | hr | $ 61.00 | $ 976.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 16.0 | hr | $ 21.30 | $ 340.80 |
| **Transportation Costs (Ref. 5)** | | | | | | | | | | |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 8.0 | hr | $ 44.78 | $ 358.24 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 8.0 | hr | $ 15.12 | $ 120.96 |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 8.0 | hr | $ 80.33 | $ 642.64 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 8.0 | hr | $ 68.70 | $ 1,099.20 |
| **Miscellaneous** | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 30 | | ton | | |
| | | | | | 20 | | | cy | $ 14.00 | $ 280.00 |
| Demolished Concrete Handling (Ref. 6) | | | | | 115.05 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 8.0 | hr | $ 245.88 | $ 1,967.04 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 8.0 | hr | $ 81.00 | $ 648.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 28.0 | hr | $ 12.00 | $ 336.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 28.0 | hr | $ 1.76 | $ 49.28 |
| **Total** | | | | | | | | | | $ 24,523.54 |

Reference Information

2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
4 - Added 5% for larger size compressor.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 13)
(Concrete Ref - 13)

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| 14 - Loading Dock and Tank Farm | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Loading Dock and Tank Farm | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| **Steel Demolition Cost** | | | | | | 5 | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 2.0 | hr | $ 140.38 | $ 280.76 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 2.0 | hr | $ 21.75 | $ 43.50 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 2.0 | hr | $ 81.00 | $ 162.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 2.0 | | $ 82.25 | $ 164.50 |
| | Common Building Labor | | CLAB | 1 | | | 2.0 | hr | $ 60.00 | $ 120.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 2.0 | hr | $ 21.30 | $ 42.60 |
| **Concrete Demolition Cost (Ref. 2,3)** | | | | | 49.3 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 8.0 | hr | $ 140.38 | $ 1,123.04 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 8.0 | hr | $ 47.03 | $ 376.24 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 8.0 | hr | $ 81.00 | $ 648.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 8.0 | hr | $ 82.25 | $ 658.00 |
| | Common Building Labor | | CLAB | 2 | | | 8.0 | hr | $ 60.00 | $ 960.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 8.0 | hr | $ 61.00 | $ 488.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 8.0 | hr | $ 21.30 | $ 170.40 |
| **Transportation Costs (Ref. 5)** | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 8.0 | hr | $ 80.33 | $ 642.64 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 8.0 | hr | $ 68.70 | $ 549.60 |
| **Miscellaneous** | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19.18 0200 | 12 ton = 8 CY | | | | 8 | | ton | | |
| | | | | | 3.33 | | | | $ 14.00 | $ 46.62 |
| Demolished Concrete Handling (Ref. 6) | | | | | 64.09 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 8.0 | hr | $ 245.88 | $ 1,967.04 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 8.0 | hr | $ 81.00 | $ 648.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 8.0 | hr | $ 12.00 | $ 96.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 8.0 | hr | $ 1.76 | $ 14.08 |
| **Total** | | | | | | | | | | $ 9,218.32 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 14)
(Concrete Ref - 14)

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| 15 - Coal Pile Retaining Wall | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Coal Pile Retaining Wall | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | 5 | | | | |
| Concrete Demolition Cost (Ref. 2,3) | | | | | 29.6 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 4.0 | hr | $ 140.38 | $ 561.52 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 4.0 | hr | $ 47.03 | $ 188.12 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 4.0 | hr | $ 82.25 | $ 329.00 |
| | Common Building Labor | | CLAB | 2 | | | 4.0 | hr | $ 60.00 | $ 480.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 4.0 | hr | $ 61.00 | $ 244.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 4.0 | hr | $ 21.30 | $ 85.20 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 4.0 | hr | $ 80.33 | $ 321.32 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 4.0 | hr | $ 68.70 | $ 274.80 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 16 0200 | 12 ton = 8 CY | | | | 5 | | ton | | |
| | | | | 3.33 | | | | cy | $ 14.00 | $ 46.62 |
| Demolished Concrete Handling (Ref. 6) | | | | | 38.48 | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 4.0 | hr | $ 245.88 | $ 983.52 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 4.0 | hr | $ 81.00 | $ 324.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 4.0 | hr | $ 12.00 | $ 48.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 4.0 | hr | $ 1.76 | $ 7.04 |
| Total | | | | | | | | | | $ 4,231.44 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 15)
(Concrete Ref - 15)

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| 16 - Sediment Pond | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Sediment Pond | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | 5 | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 2.0 | hr | $ 140.38 | $ 280.76 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 2.0 | hr | $ 21.75 | $ 43.50 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 2.0 | hr | $ 81.00 | $ 162.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 2.0 | hr | $ 82.25 | $ 164.50 |
| | Common Building Labor | | CLAB | 1 | | | 2.0 | hr | $ 60.00 | $ 120.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 2.0 | hr | $ 21.30 | $ 42.60 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 2.0 | hr | $ 80.33 | $ 160.66 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 2.0 | hr | $ 68.70 | $ 137.40 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 16 0200 | 12 ton = 8 CY | | | | 5 | | ton | | |
| | | | | | 3.33 | | | cy | $ 14.00 | $ 46.62 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 2.0 | hr | $ 12.00 | $ 24.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 2.0 | hr | $ 1.76 | $ 3.52 |
| Total | | | | | | | | | | $ 1,185.56 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 16)

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17 - Portal

Replaced with Demolition Sheet 19- Portal Liners and Earthwork Sheet Dozer/Track-Hoe Work

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| 18 - Culvert Removal | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Culvert Removal | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| Steel Demolition Cost | | | | | | 104.5 | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 40.0 | hr | $ 140.38 | $ 5,615.20 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 40.0 | hr | $ 21.75 | $ 870.00 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 40.0 | hr | $ 81.00 | $ 3,240.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 40.0 | hr | $ 82.25 | $ 3,290.00 |
| | Common Building Labor | | CLAB | 2 | | | 40.0 | hr | $ 60.00 | $ 4,800.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 40.0 | hr | $ 21.30 | $ 852.00 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 8.0 | hr | $ 44.78 | $ 358.24 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 8.0 | hr | $ 15.12 | $ 120.96 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 8.0 | hr | $ 68.70 | $ 549.60 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 104.5 | | ton | | |
| | | | | | 69.66 | | | cy | $ 14.00 | $ 975.24 |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 40.0 | hr | $ 245.88 | $ 9,835.20 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 40.0 | hr | $ 81.00 | $ 3,240.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 40.0 | hr | $ 12.00 | $ 480.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 40.0 | hr | $ 1.76 | $ 70.40 |
| Total | | | | | | | | | | $ 34,296.84 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 18)

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| 19 - Portal Liners | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Portal Framework and Liners | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| Concrete Demolition Cost (Ref. 2,3) | 8 - Portals | | | | 82 | | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 48.0 | hr | $ 140.38 | $ 6,738.24 |
| | 01 54 33 20 0347 | Hydraulic Hammer | | 1 | | | 48.0 | hr | $ 47.03 | $ 2,257.44 |
| | Foreman Average, Outside | | Foreman | 1 | | | 48.0 | hr | $ 82.25 | $ 3,948.00 |
| | Common Building Labor | | CLAB | 2 | | | 48.0 | hr | $ 60.00 | $ 5,760.00 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 48.0 | hr | $ 81.00 | $ 3,888.00 |
| | 01 54 33 40 0700 | Compressor - 600 CFM | | 1 | | | 48.0 | hr | $ 61.00 | $ 2,928.00 |
| | 01 54 33 40 0930 | Air tools, breaker, pavement, 60 lb. | | 1 | | | | ea | $ 10.20 | $ 10.20 |
| | 01 54 33 40 1100 | Hose w/couplings 50 ft., 1" dia. | | 1 | | | | ea | $ 4.10 | $ 4.10 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 48.0 | hr | $ 21.30 | $ 1,022.40 |
| Miscellaneous | | | | | | | | | | |
| | | | | | | | | | | |
| Portals Sealing -Wall construction | 04 27 10 30 0850 | 216 sf each x 8 portals | | 1728 | | | | sf | $ 15.05 | $ 26,006.40 |
| | | | | | | | | | | |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 48.0 | hr | $ 12.00 | $ 576.00 |
| | 01 54 33 40 8410 | Toilet, portable chemical | | 1 | | | 48.0 | hr | $ 1.76 | $ 84.48 |
| Total | | | | | | | | | | $ 53,223.26 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Notes: Portal liner is based on (2) wing walls 8'x12'x8" either side portal opening and 1 header 2'x28'x12" across the top of the wing wall (3 portals).
Bond sheet adjusted in 2017 to include 5 additional portals for 8 total
For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet

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| 20 - Gunite/Shotcrete Removal | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Gunite/Shotcrete Removal | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | 5 | | | | |
| | 01 54 33 20 0300 | Excavator - 2.0 CY | | 1 | | | 8.0 | hr | $ 140.38 | $ 1,123.04 |
| | 01 54 33 20 0342 | Bucket Thumb | | 1 | | | 8.0 | hr | $ 21.75 | $ 174.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 8.0 | hr | $ 81.00 | $ 648.00 |
| | Common Building Labor | | CLAB | 1 | | | 8.0 | hr | $ 82.25 | $ 658.00 |
| | Equipment Operator, Medium Equipment | | Eqhv | 1 | | | 8.0 | hr | $ 60.00 | $ 480.00 |
| | 01 54 33 40 0190 | Aerial Lift, 60 feet | | 1 | | | 8.0 | hr | $ 60.71 | $ 485.68 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 8.0 | hr | $ 21.30 | $ 170.40 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 4.0 | hr | $ 80.33 | $ 321.32 |
| | Truck Driver, Heavy | | Drhv | 2 | | | 4.0 | hr | $ 68.70 | $ 549.60 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 5 | | ton | | |
| | | | | 3.33 | | | | cy | $ 14.00 | $ 46.62 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 8.0 | hr | $ 12.00 | $ 96.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 8.0 | hr | $ 1.76 | $ 14.08 |
| Total | | | | | | | | | | $ 4,766.74 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 20)

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| 21 - Rock Dust Tank | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Rock Dust Tank | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total Cost |
| Steel Demolition Cost | | | | | | 15 | | | | |
| | 01 54 33 60 2200 | Crane, 115 ton | | 1 | | | 2.0 | hr | $ 228.30 | $ 456.60 |
| | Equipment Operator, Crane or Shovel | | Eqhv | 1 | | | 2.0 | hr | $ 84.25 | $ 168.50 |
| | Foreman Average, Outside | | Foreman | 1 | | | 2.0 | hr | $ 82.25 | $ 164.50 |
| | Common Building Labor | | CLAB | 1 | | | 2.0 | hr | $ 60.00 | $ 120.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 2.0 | hr | $ 21.30 | $ 42.60 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 2.0 | hr | $ 44.78 | $ 89.56 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 2.0 | hr | $ 15.12 | $ 30.24 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 2.0 | hr | $ 68.70 | $ 137.40 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 15 | | ton | | |
| | | | | | 10 | | | cy | $ 14.00 | $ 140.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 2.0 | hr | $ 12.00 | $ 24.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 2.0 | hr | $ 1.76 | $ 3.52 |
| Total | | | | | | | | | | $ 1,376.92 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill, Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 21)

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| 22 - Fence Removal | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Fence Removal | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| Steel Demolition Cost | | | | | | 10 | | | | |
| | 01 54 33 40 0470 | Back-hoe 112hp | | 1 | | | 8.0 | hr | $ 86.08 | $ 688.64 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 8.0 | hr | $ 84.25 | $ 674.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 8.0 | hr | $ 82.25 | $ 658.00 |
| | Common Building Labor | | CLAB | 2 | | | 8.0 | hr | $ 60.00 | $ 960.00 |
| | 01 54 33 40 6360 | Torch, cutting, acetylene-oxygen 150' hose | | 1 | | | 8.0 | hr | $ 21.30 | $ 170.40 |
| Transportation Costs (Ref. 5) | | | | | | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 1 | | | 4.0 | hr | $ 80.33 | $ 321.32 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 4.0 | hr | $ 68.70 | $ 274.80 |
| Miscellaneous | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 10 | | ton | | |
| | | | | | 6.67 | | | cy | $ 14.00 | $ 93.38 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 8.0 | hr | $ 12.00 | $ 96.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 8.0 | hr | $ 1.76 | $ 14.08 |
| Total | | | | | | | | | | $ 3,950.62 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.
6 - A swell factor of 1.3 is used for crushed concrete.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 22)

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| 23 - Asphalt Removal | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Asphalt Removal | Means Reference Number<br>(2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity<br>(number) | Volume<br>(cy) | Weight<br>(tons) | Time<br>(hr) | Unit | Cost | Total<br>Cost |
| Transportation Costs (Ref. 5,6) | | | | | 838.37 | | | | | |
| | 01 54 33 20 5300 | Dump Truck - 3 axle, 12 CY | | 3 | | | 36.0 | hr | $ 80.33 | $ 8,675.64 |
| | Truck Driver, Heavy | | Drhv | 3 | | | 36.0 | hr | $ 68.70 | $ 7,419.60 |
| Miscellaneous | | | | | | | | | | |
| | 01 54 33 20 4810 | Loader - 8 CY | | 1 | | | 36.0 | hr | $ 245.88 | $ 8,851.68 |
| | Equipment Operator, Medium Equipment | | Eqmd | 1 | | | 36.0 | hr | $ 81.00 | $ 2,916.00 |
| Disposal Fee - Asphalt (Ref. 7) | 02 41 19.18 0400 | | | | 644.9 | 1131.8 | | cy | $ 13.68 | $ 8,822.23 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 36.0 | hr | $ 12.00 | $ 432.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 36.0 | hr | $ 1.76 | $ 63.36 |
| Total | | | | | | | | | | $ 37,180.51 |

Reference Information
2 - Concrete rubble disposed of as fill or permanently backfilled inside portals.
3 - Base on a concrete demolition production of 200 cubic yards per 8 hour shift. (Reference: http://www.indeco-breakers.com). Time increases depending on complexity of job.
5 - For haul of asphalt demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip. Transportation dictates all machinery and labor times.
6 - A swell factor of 1.3 is used for asphalt.
7 - Assume weight of crushed asphalt is approximately 3510 lbs/cy (Ref. US Federal Highway Administration, Publication Number: FHWA-RD-97-148). Original quantity is 644.9 cy.
Asphalt will be hauled to Nielson Construction landfill and permanently disposed (Ref. personal communication with Nielson Construction). This landfill is a class 1 landfill.

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| Earthwork Cost Summary | |
|---|---|
| Description | Cost |
| Earthwork | $ 95,958.88 |
| Riprap | $ 18,211.69 |
| | |
| Total | $ 114,170.57 |

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**Earthwork - Dozer/Track-Hoe Work**

| Reference Number | Station Location/Type Equipment | Source | Hourly Equipment Cost | Hourly Operating Cost | Operator's Hourly Wage Rate | Equipment Overhead | Hourly Cost | Number of Men or Eq. | Total Eq. & Lab. Costs | Units | Quantity | Units | Production Rate | Units | Equip. + Labor Time/Qty. | Units | Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9-41 | 992G Hours - Loader | PH 2017 Rental Rate Blue Book | $ 94.00 | $ 23.10 | $ 61.80 | $ 6.10 | $ 185.00 | 1 | $ 185.00 | Hour | 79,710.0 | CY | 112.5 | CY/Hr | 708.3 | Hrs | $ 37,411.01 |
| 16-22 | CAT 375CL Excavator | PH 2017 Rental Rate Blue Book | $ 150.00 | $ 54.00 | $ 61.80 | $ 6.10 | $ 277.40 | 1 | $ 277.40 | Hour | | | (see note) | | 172.83 | Hrs | $ 34,767.85 |
| 9-41 | 992G Hours - Loader | PH 2017 Rental Rate Blue Book | $ 94.00 | $ 23.10 | $ 61.80 | $ 6.10 | $ 185.00 | 1 | $ 185.00 | Hour | 2563 | CY | 112.5 | CY/Hr | 11 | Hrs | $ 2,036.12 |
| 16-22 | CAT 375CL Excavator | PH 2017 Rental Rate Blue Book | $ 150.00 | $ 54.00 | $ 61.80 | $ 6.10 | $ 277.40 | 1 | $ 277.40 | Hour | | | (see note) | | 0.6 | Hrs | $ 731.97 |
| | Sub-Totals | | | | | | | | | | | | | | | | $ 72,703.85 |
| Miscellaneous | | | | | | | | | | | | | | | | | |
| | Foreman Average, Dozing | | | | | | $ 71.20 | 1.0 | $ 71.20 | Shift | | | | | 351.3 | Hrs | $ 25,012.56 |
| 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | | | | | $ 12.00 | 1.0 | $ 12.00 | Shift | | | | | 351.3 | Hrs | $ 4,214.52 |
| | Total Earthwork | | | | | | | | | | | | | | | | $ 101,930.93 |

Notes: Track-Hoe is utilized to support Dozer activities. Usage is dictated by 1/2 Dozer hours.
Backfill Portals (12 X 16 X 4 feet) 32 cy each - 8 portals = 256 cy

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| Earthwork - RipRap Work | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reference Number | Station Location/Type Equipment | Source | Hourly Equipment Cost | Hourly O & P Cost | Operator's Hourly Wage Rate | Material | Hourly Cost | Number of Men or Eq. | Total Eq. & Lab. Costs | Units | Quantity | Units | Production Rate | Units | Equip. + Labor Time/Dis. | Units | Cost |
| 9-61 | 924G EROPS - Loader | 2H 2017 Rental Rate Blue Book | $38.00 | $23.70 | $81.00 | $0.10 | $148.87 | 1 | $148.87 | $/HR | 1,989.0 | CY | 50 | LF/HR | 39.78 | HR | $4,611.25 |
| 10-33 | CAT 325CL Excavator | 2H 2017 Rental Rate Blue Book | $120.00 | $58.60 | $81.00 | $0.10 | $277.46 | 1 | $277.46 | $/HR | | | | | 39.78 | HR | $11,459.10 |
| | Sub-Totals | | | | | | | | | | | | | | | | $ 16,070.35 |
| Miscellaneous | | | | | | | | | | | | | | | | | |
| 31 37 13.10 0100 | Riprap & Rock Lining (Incl. O&P) | RS Means 2017 | $ 11.93 | $ 11.00 | $ 12.40 | $ 31.42 | $ 66.75 | | | | 1,060.0 | CY | 62.0 | LFCY/HR | 32.08 | HR | $ 2,141.34 |
| | Total Earthwork | | | | | | | | | | | | | | | | $ 18,211.69 |

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**Fossil Rock Mine Revegetation**

| Pocking | Reference Number | Equipment Rental (hr) (Includes O & P) | Operator's Hourly Wage | Material Cost | Labor Hourly Cost | Unit | Number | Area (AC) | Quantity | Units | Production Rate | Units | Time | Units | Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Excavator, 2 CY | 01 54 33 20 0300 (RSM 2017) | $140.38 | $81.00 | | | | | | | | | | | | |
| | | | | | | | | 10.4 | | AC | | | | | |
| Volume | | | | | | | | | 3532.6 | CY | 340 | CY/AC | | | |
| | | $140.38 | $81.00 | | | | 1 | | | | 180 | CY/HR | 19.6 | HR | $4,345 |
| Subtotal | | | | | | | | | | | | | | | $4,345 |
| Seeding/Planting | | | | | | | | | | | | | | | |
| Seed Mix - Riparian | Stevenson Intermountain Seed | | | $ 479.18 | | $/AC | 2 | 0.78 | 26.5 | LBS | | | | | $ 747.52 |
| Seed Mix - Grassland/Shrub | Stevenson Intermountain Seed | | | $ 730.06 | | $/AC | 2 | 9.61 | 403.6 | LBS | | | | | $ 14,031.75 |
| Container plants** | | | | $ 2.17 | | | | | 1006 | Containers | | | | | $ 2,183.02 |
| CLAB | | | | | $ 60.00 | | 4 | | | | 48 | Cont/HR | 20.96 | | $ 5,030.00 |
| Intermediate Total | | | | | | | | | | | | | | | $ 21,992.29 |
| Add 25% Reseeding Cost | | | | | | | | | | | | | | | $ 5,498.07 |
| Subtotal | | | | | | | | | | | | | | | $ 27,490.37 |
| Mulching | | | | | | | | | 10.39 | AC | | | | | |
| Hay, Large Power Mulcher***** | 32 91 13.16 0350 | $ 7.00 | $ 1.50 | $ 57.00 | | msf | | | 452.58 | EA | | | | | $ 29,643.99 |
| Flatbed Truck & Driver **** | | | | | | | | | | | | | | | |
| CLAB**** | | | | | | | | | | | | | | | |
| Hydromulcher, 3000 gal***** | 32 92 19.14 5000 $ | $ 19.93 | $ 13.09 | $ 29.28 | | msf | | | 452.58 | EA | | | | | $ 28,195.73 |
| Flatbed Truck & Driver **** | | | | | | | | | | | | | | | |
| Additional Fertilizer | $$ | | | $ 3.00 | | msf | | | 453 | EA | | | | | $ 1,359.00 |
| Wood Fiber Mulch**** | | | | | | | | | | | | | | | |
| CLAB**** | | | | | | | | | | | | | | | |
| Subtotal | | | | | | | | | | | | | | | $ 59,198.72 |
| Total | | | | | | | | | | | | | | | $ 91,033.80 |

* Seedmix prices based on Stevenson Intermountain Seed Prices quoted inNovember 2017. See attached.
** Seedling tree prices based on Lawyer and Montanta Conservation Nurserys Prices in November 2017. See attahed.
*** Included
***** 10.39 acres = 4,525,884 sf RS Means Units M.S.F. or 1,000 sf (4,525,884 /1000 = 452.58)
Hay Quantity (4000 LBS/AC)
$ Water Soluable Fertilizer, included in hydro mulch solution
$$ Addition of Fertilizer to Fertilizer included with hydro mulch solution ( per Jeatchel DOGM 2018)

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| Rock Dust Tank and Fence Removal | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Description<br>Rock Dust Tank | Means Reference Number (2017 Heavy Construction Cost Data) | Equipment | Labor | Quantity (number) | Volume (cy) | Weight (tons) | Time (hr) | Unit | Cost | Total Cost |
| **Steel Demolition Cost** | | | | | | 5 | | | | |
| | 01 54 33 20 0300 | Ecavator | | 1 | | | 8.0 | hr | $ 140.38 | $ 1,123.04 |
| | Equipment Operator, Medium | | Eqmd | 1 | | | 8.0 | hr | $ 81.00 | $ 648.00 |
| | Foreman Average, Outside | | Foreman | 1 | | | 8.0 | hr | $ 82.25 | $ 658.00 |
| | Common Building Labor | | CLAB | 1 | | | 8.0 | hr | $ 60.00 | $ 480.00 |
| **Transportation Costs (Ref. 5)** | | | | | | | | | | |
| | 01 54 33 40 7300 | Tractor, 4x2, 220hp | | 1 | | | 1.0 | hr | $ 44.78 | $ 44.78 |
| | 01 54 33 40 6500 | Trailer, platform, flush deck, 2 axle, 25 ton | | 1 | | | 1.0 | hr | $ 15.12 | $ 15.12 |
| | Truck Driver, Heavy | | Drhv | 1 | | | 1.0 | hr | $ 68.70 | $ 68.70 |
| **Miscellaneous** | | | | | | | | | | |
| Disposal Fee - Metal | 02 41 19 18 0200 | 12 ton = 8 CY | | | | 5 | | ton | | |
| | | | | | 10 | | | cy | $ 14.00 | $ 140.00 |
| Net Fence Removal (Ref. 4) | 02 41 13.60 1600 | | CLAB | 2 | | | 64.0 | HR | $ 60.00 | $ 7,680.00 |
| | 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | 1 | | | 2.0 | hr | $ 12.00 | $ 24.00 |
| | 01 54 33 40 6410 | Toilet, portable chemical | | 1 | | | 2.0 | hr | $ 1.76 | $ 3.52 |
| **Total** | | | | | | | | | | **$ 10,885.16** |

Reference Information
4 - Net Fence, 3500 linear feet. Demoliton prosuction rate is 430 lf/day
5 - For haul of steel demolition material to Nielsen's landfill. Distance is approximately 16.0 miles one-way. Time estimate is 1.5 hours for one round trip.

Note: For concrete volumes and steel weights, refer to Concrete and Steel Estimations sheet
(Steel Ref - 21)

**Earthwork - Dozer/Track-Hoe Work**

| Reference Number | Station Location/Type Equipment | Source | Hourly Equipment Cost | Hourly Operating Cost | Operator's Hourly Wage Rate | Equipment Overhead | Hourly Cost | Number of Men or Eq. | Total Eq. & Lab. Costs | Units | Quantity | Units | Production Rate | Units | Equip. + Labor Time/Dia. | Units | Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PHASE 1 | | | | | | | | | | | | | | | | | |
| 9-61 | 924G EROPS - Loader | 2H 2017 Rental Rate Blue Book | $ 38.00 | $ 23.70 | $ 81.00 | $ 0.10 | $ 148.87 | 1 | $ 148.87 | $/HR | 54,500.0 | CY | 156.0 | CY/HR | 344.9 | HR | $ 51,345.26 |
| 10-33 | CAT 325CL Excavator | 2H 2017 Rental Rate Blue Book | $ 120.00 | $ 58.60 | $ 81.00 | $ 0.10 | $ 277.46 | 1 | $ 277.46 | $/HR | | | (see note) | | 172.45 | HR | $ 47,847.96 |
| PHASE 2 | | | | | | | | | | | | | | | | | |
| 9-61 | 924G EROPS - Loader | 2H 2017 Rental Rate Blue Book | $ 38.00 | $ 23.70 | $ 81.00 | $ 0.10 | $ 148.87 | 1 | $ 148.87 | $/HR | 6,233.0 | CY | 158.0 | CY/HR | 39.4 | HR | $ 5,865.48 |
| 10-33 | CAT 325CL Excavator | 2H 2017 Rental Rate Blue Book | $ 120.00 | $ 58.60 | $ 81.00 | $ 0.10 | $ 277.46 | 1 | $ 277.46 | $/HR | | | (see note) | | 19.7 | HR | $ 5,465.96 |
| ACCESS ROAD | | | | | | | | | | | | | | | | | |
| 10-33 | CAT 325CL Excavator | 2H 2017 Rental Rate Blue Book | $ 120.00 | $ 58.60 | $ 81.00 | $ 0.10 | $ 277.46 | 1 | $ 277.46 | $/HR | 1,435.0 | LF | 200.0 | LF/Day | 57.4 | HR | $ 15,926.20 |
| | | | | | | | | | | | | | (see note) | | | | |
| | Sub-Totals | | | | | | | | | | | | | | | | $ 126,450.85 |
| Miscellaneous | | | | | | | | | | | | | | | | | |
| PHASE 1 | | | | | | | | | | | | | | | | | |
| | Foreman Average, Outside | | | | | | $ 71.20 | 1 | $ 82.25 | $/HR | | | | | 344.9 | HR | $ 28,368.00 |
| 01 54 3+A17-R17) 40 7200 | Pickup Truck - 3/4 ton 4x4 | | | | | | $ 12.00 | 1 | $ 12.00 | $/HR | | | | | 344.9 | HR | $ 4,139.00 |
| PHASE 2 | | | | | | | | | | | | | | | | | |
| | Foreman Average, Outside | | | | | | $ 71.20 | 1 | $ 82.25 | $/HR | | | | | 39.4 | HR | $ 3,241.00 |
| 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | | | | | $ 12.00 | 1 | $ 12.00 | $/HR | | | | | 39.4 | HR | $ 473.00 |
| ACCESS ROAD | | | | | | | | | | | | | | | | | |
| | Foreman Average, Outside | | | | | | $ 71.20 | 1 | $ 82.25 | $/HR | | | | | 57.4 | HR | $ 4,721.00 |
| 01 54 33 40 7200 | Pickup Truck - 3/4 ton 4x4 | | | | | | $ 12.00 | 1 | $ 12.00 | $/HR | | | | | 57.4 | HR | $ 689.00 |
| | Sub-Totals | | | | | | | | | | | | | | | | $ 41,631.00 |
| Riprap Channels | | | | | | | | | | | | | | | | | |
| 9-61 | 924G EROPS - Loader | 2H 2017 Rental Rate Blue Book | $38.00 | $23.70 | $81.00 | $0.10 | $148.87 | 1 | $148.87 | $/HR | 660.0 | LF | 50 | LF/HR | 13.2 | HR | $1,965.08 |
| 10-33 | CAT 325CL Excavator | 2H 2017 Rental Rate Blue Book | $120.00 | $58.60 | $81.00 | $0.10 | $277.46 | 1 | $277.46 | $/HR | | | | | 13.2 | HR | $3,662.47 |
| | Sub-Totals | | | | | | | | | | | | | | | | $ 5,627.55 |
| Miscellaneous | | | | | | | | | | | | | | | | | |
| 31 37 13.10 0100 | Riprap & Rock Lining (Incl. O&P) | RS Means 2017 | $ 11.93 | $ 11.00 | $ 12.40 | $ 31.42 | $ 66.75 | | | | 660.0 | LF | 62.0 | LF/HR | 13.2 | HR | $ 881.10 |
| | Sub-Totals | | | | | | | | | | | | | | | | $ 6,508.65 |
| Earthwork Total | | | | | | | | | | | | | | | | | $ 180,218.10 |

Notes: Track-hoe is utilized to support Dozer activities. Usage is dictated by 1/2 Dozer hours.

**Fossil Rock Mine Revegetation**

| Pocking | Reference Number | Equipment Rental (hr) (Includes O & P) | Operator's Hourly Wage | Material Cost | Labor Hourly Cost | Unit | Number | Area (AC) | Quantity | Units | Production Rate | Units | Time | Units | Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Excavator, 2 CY | 01 54 33 20 0300 (RSM 2017) | $140.38 | $81.00 | | | | | | | | | | | | |
| | | | | | | | | 18.0 | | AC | | | | | |
| Volume | | | | | | | | | 6120.0 | CY | 340 | CY/AC | | | |
| | | $140.38 | $81.00 | | | | 1 | | | | 180 | CY/HR | 34.0 | HR | $7,527 |
| Soil Testing ( 2 per acre) | Inter-Mountain Labs & | | | $ 132.00 | | ea | | | 36 | | | | | | $4,752 |
| | | | | | | | | | | | | | | | |
| Subtotal | | | | | | | | | | | | | | | $12,279 |
| Seeding/Planting | | | | | | | | | | | | | | | |
| Seed Mix - Grassland/Shrub | Stevenson Intermountain Seed | | | $ 730.06 | | $/AC | 1 | 18 | 378.0 | LBS | | | | | $ 13,141.08 |
| Intermediate Total | | | | | | | | | | | | | | | $ 13,141.08 |
| Add 25% Reseeding Cost | | | | | | | | | | | | | | | $ 3,285.27 |
| Subtotal | | | | | | | | | | | | | | | $ 16,426.35 |
| Mulching | | | | | | | | | 18 | AC | | | | | |
| Hay, Large Power Mulcher***** | 32 91 13.16 0350 | $ 7.00 | $ 1.50 | $ 57.00 | | msf | | | 784.08 | EA | | | | | $ 51,357.24 |
| Flatbed Truck & Driver **** | | | | | | | | | | | | | | | |
| CLAB**** | | | | | | | | | | | | | | | |
| Hydromulcher, 3000 gal***** | 32 92 19.14 5000 $ | $ 19.93 | $ 13.09 | $ 29.28 | | msf | | | 784.08 | EA | | | | | $ 48,848.18 |
| Flatbed Truck & Driver **** | | | | | | | | | | | | | | | |
| Additional Fertilizer | $$ | | | $ 3.00 | | msf | | | 784 | EA | | | | | $ 2,352.00 |
| Wood Fiber Mulch**** | | | | | | | | | | | | | | | |
| CLAB**** | | | | | | | | | | | | | | | |
| Subtotal | | | | | | | | | | | | | | | $ 102,557.42 |
| Total | | | | | | | | | | | | | | | $ 131,262.69 |

* Seed mix prices based on Stevenson Intermountain Seed Prices quoted in November 2017. See attached.
*** Included
***** 18 acres = 784080 sf RS Means Units M.S.F. or 1,000 sf (784080 /1000 =784.08)
Hay Quantity (4000 LBS/AC)
$ Water Soluble Fertilizer, included in hydro mulch solution
$$ Addition of Fertilizer to Fertilizer included with hydro mulch solution ( per jeatchel DOGM 2018)
& Inter-Mountain Labs (Sheridan, Wyoming) Analytical Invoice 2017

# Price Quotation

**Date: 11/15/2017**
**Quoted By: Jason**

STEVENSON
INTERMOUNTAIN SEED, INC.
P.O. Box 2, Ephraim, UT 84627
Phone: (435) 283-6639 Fax:(435) 283-4155
Email:sales@siseed.com

**Quote to (Company):** Fossil Rock Mine
**Address:**

**Contact Person:** Vicky Miller
**Phone:** 435-286-4481
**Fax:**
**Email:** vmiller@bowieresources.com

| Quantity Pounds | Bulk-PLS | Lot No. | Species | Variety | Additional Information | Price /Pound | Total Cost |
|---|---|---|---|---|---|---|---|
| 2.7 | PLS | | Slender Wheatgrass | | | $ 3.25 | $ 8.78 |
| 1.21 | PLS | | Mountain Brome | | | $ 5.00 | $ 6.05 |
| 3.3 | PLS | | Great Basin Wildrye | | | $ 12.50 | $ 41.25 |
| 2.3 | PLS | | Indian Ricegrass | | | $ 7.50 | $ 17.25 |
| 0.08 | PLS | | Western Yarrow | | | $ 32.00 | $ 2.56 |
| 0.5 | PLS | | Cicer Milkvetch | | | $ 8.00 | $ 4.00 |
| 0 | pls | | Nuttall Lomatium | | | NA | NA |
| 0.3 | PLS | | Yellow Sweet Clover | | | $ 4.25 | $ 1.28 |
| 0.1 | PLS | | Palmer Penstemon | | | $ 36.00 | $ 3.60 |
| 3.3 | PLS | | Utah Service Berry | | | $ 85.00 | $ 280.50 |
| 5.6 | PLS | | Antelope Bitterbrush | | | $ 38.00 | $ 212.80 |
| 1.6 | pls | | Silvery Lupine | | *Substitute for Nuttal Lomatium | $ 95.00 | $ 152.00 |
| | | | | | | | $ - |
| | | | | | | $ 326.50 | $ - |
| | | | | | | | $ - |
| | | | | | | | $ - |
| | | | | | | | $ - |
| | | | | | | | $ - |
| | | | | | | | $ - |

**Project Name/No.: Grasslands/ Shrub Community (9.61ac)**
**Mix:** X **Separates:**
**Shipped Via:** Best Way
**FOB:** Origin
**Terms:** Net 30
**Additional Information:** Price is per ac

## Thank You!

We appreciate your request
for a price quotation and your business.

| | |
|---|---|
| **Sub Total:** | $ 730.06 |
| **Tax:** | None |
| **Mixing/Handling:** | None |
| **Shipping:** | TBD |
| **Total:** | $ 730.06 |

Concrete Volume Estimation[1]/Steel Demolition[2]

| Ref Sheet | Facility Description | Length | Width | Height | Area | Radius | CF | CY | Tons | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Substation | | | | | | | | 15 | |
| | Retaining Wall | 275 | 0.67 | 5 | | | 921.25 | 34.1 | | Estimated and average height of 5' |
| | Pads | | 1 | | 920 | | 920 | 34.1 | | |
| | Foundation | 275 | 3 | 1 | | | 825 | 30.6 | | |
| | Total | | | | | | | 98.8 | 15 | |
| 02 | Office/Shop/Bathhouse/Warehouse | | | | | | | | 30 | considers metal in office, bathhouse, and shop plus includes demo of wood framed office |
| | Pads | | 0.5 | | 4904 | | 2452 | 90.8 | | |
| | Retaining Wall | 25 | 0.67 | 5 | | | 83.75 | 3.1 | | |
| | Foundation | 362 | 2 | 1 | | | 724 | 26.8 | | |
| | Concrete Block Walls | 520 | 0.67 | 16 | | | 5574.4 | 138.3 | | CY multiplied by .67 to account for air space of blocks |
| | Total | | | | | | | 259.1 | 30 | |
| 03 | Water Treatment Plant, Water Storage Tanks and Fuel Storage Facility | | | | | | | | 10 | |
| 04 | Sewer System/Collection Pumping | | | | | | | | 15 | misc equipment |
| | Walls | 90 | 0.67 | 8 | | | 482.4 | 17.9 | | |
| | Pads | | 0.33 | | 476 | | 157.08 | 5.8 | | |
| | Foundation | 90 | 2 | 1 | | | 180 | 6.7 | | |
| | Total | | | | | | | 30.4 | 15 | |
| 05 | Concrete Pads | | | | | | | | | |
| | Curb and Gutter | 1300 | 2 | 1 | | | 2600 | 96.3 | | |
| | Miscellaneous Other | | | | | | | 500.0 | | Arbitrarily added yardage to cover all miscellaneous concrete |
| | Total | | | | | | | 596.3 | | |
| 06 | Pumphouse, Tanks and Concrete Pads | | | | | | | | 55 | Steel demo includes raw water tank, lines, and pumphouse building |
| | Pumphouse - foundation | 140 | 2 | 1 | | | 280 | 10.4 | | |
| | Pumphouse - stemwall | 140 | 3 | 0.67 | | | 281.4 | 10.4 | | |
| | Pumphouse - pad | 45 | 20 | 0.5 | | | 450 | 16.7 | | |
| | Area Pad | | | 0.5 | 5062.1 | | 2531.05 | 93.7 | | Includes pads around pumphouse, tanks, and water treatment building |
| | Tank - foundation | | | 1 | 188.5 | 15 | 188.5 | 7.0 | | perimeter is equal to approx 100' |
| | Tank - pad | | 0.5 | | 706.85 | | 353.425 | 13.1 | | pad around water treatment, water tank, and pumphouse |
| | Total | | | | | | | 151.3 | 55 | |
| 07 | Non Coal Waste Bunker and Salt Bunkers | 84 | 0.67 | 8 | | | 450.24 | 16.7 | 30 | |
| 08 | Truck Loadout Silo (pad) | | 1 | | 615.734 | 14 | 615.734 | 22.8 | 30 | misc equipment, rebar, etc. |
| 09 | Chute and Trusses from Crusher | | | | | | | | 30 | |
| 10 | Main Fan | | | | | | | | 30 | |
| | Walls | 245 | 0.67 | 8 | | | 1313.2 | 48.6 | | |
| | Pads | | 0.5 | | 4304 | | 2152.0 | 79.7 | | |
| | Top | | 0.33 | | 2484 | | 819.7 | 30.4 | | |
| | Total | | | | | | | 158.7 | 30 | |
| 11 | Storage Shed | | | | | | | | 15 | |
| 12 | ROM Transfer Building | | | | | | | | 50 | |
| 13 | ROM Overland Tube Conveyor | | | | | | | | 30 | |
| | Bent Structure Foundation | 34.5 | 15 | 4 | | | 2070.0 | 76.7 | | |
| | Support Platform | 20 | 4 | 4 | | | 320.0 | 11.9 | | |
| | Total | | | | | | | 88.5 | 30 | |
| 14 | Loading Dock/Tank Farm | | | | | | | | 5 | Steel estimates include rebar and steel edge protectors |
| | Pads | | 0.33 | | 1492 | | 492.4 | 18.2 | | |
| | Walls | 175 | 0.67 | 4 | | | 469.0 | 17.4 | | |
| | Foundation | 175 | 2 | 1 | | | 350.0 | 13.0 | | |
| | Stairs | 14 | 4 | 0.33 | | | 18.5 | 0.7 | | |
| | Total | | | | | | | 49.3 | 5 | |
| 15 | Coal Pile Retaining Wall - Includes all | 150 | 0.667 | 8 | | | 800.4 | 29.6 | 5 | Steel estimates include rebar and steel edge protectors |
| 16 | Sediment Pond | | | | | | | | 5 | |
| 17 | Portals - Sealing | | | | | | | | | Not applicable to demolition costs |
| 18 | Culvert Removal | | | | | | | | | |
| | 12" - 326' @ 12lbs/ft | | | | | | | | 2 | weights based on Hanson Corrugated Steel Pipe chart 2 2/3" x 1/2" (avg. of all thicknesses) |
| | 18" - 60' @ 18lbs/ft | | | | | | | | 0.5 | weights based on Hanson Corrugated Steel Pipe chart 2 2/3" x 1/2" (avg. of all thicknesses) |
| | 48" - 136' @ 76lbs/ft | | | | | | | | 5 | weights based on Hanson Corrugated Steel Pipe chart 3" x 1" (avg. of all thicknesses) |
| | 66" - 1914' @ 101lbs/ft | | | | | | | | 97 | weights based on Hanson Corrugated Steel Pipe chart 3" x 1" (avg. of all thicknesses) |
| | Total | | | | | | | | 104.5 | |
| 19 | Portal Liners | 40 | 8 | 1 | | | 320.0 | 11.9 | | |
| 20 | Gunite Removal | | | | | | | | 5 | fencing |
| 21 | Rock Dust Tank | | | | | | | | 15 | |
| N/A | Concrete Barriers | | | | | | | | | Mobile items. Will be removed from site by others prior to reclamation |
| 22 | Fence Removal | | | | | | | | 10 | |
| 23 | Asphalt | | 0.33 | | 52761 | | 17411.1 | 644.9 | | Transported to Nielson's Landfill |
| | Grand Total | | | | | | Total | 1513.2 | 435 | Grand total does not include volume of asphalt |

1 Concrete quantity estimates are based on volumes generated from an AutoCAD drawing of the surface facilities at Trail Mountain Mine, or actual field measurements, and not actual pour tickets or contractor invoices.

2 Steel weights for demolition are estimated.

# APPENDIX 5-2

# MULTIPLE SEAM CONSIDERATION ( FORMERLY APPENDIX 3-2)

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 3-2

## MULTIPLE SEAM CONSIDERATION

Estimated Maximum Economic Recovery—~~MER~~
and Mining Method for Natomas Coal Company
Emergency Coal Lease Application U-49332

August 25, 1982

The emergency lease tract lies within the Wasatch Plateau KRCRA approximately 10 miles northwest of Orangeville, Utah, and has the following land description:

T. 17 S., R. 6 E., SLM, Emery County, Utah

sec. 25: S½NW¼, W½SW¼, and W½E½SW¼;
sec. 26: SE¼NE¼, E½SW¼NE¼, E½SE¼, and E½W½SE¼;
sec. 35: lot 1 and E½ of lot 2, and SE¼NE¼,
E½SW¼NE¼, E½SE¼, and E½W½SE¼.

Containing 641.47 acres.

The Hiawatha is the only coal seam of current economic interest underlying the tract. In addition to coal, the lands of the area are also valuable prospectively for oil and gas. Lands under the original coal lease U-082996 are also under oil and gas lease U-10849. However, the value of this land for oil and gas has not been established.

Coal beds in this area are contained in the Blackhawk formation. The coal dips approximately 4° to the southwest and the overburden ranges from 750 feet in the northwest to about 2,250 feet in the west. Locally, irregularly shaped dikes and sills of very tough fine-grained clayey sandstone occur erratically within the Hiawatha seam. Ranging up to 3 feet in thickness, these structures complicate mining and increase the costs of recovering the coal.

Total recoverable reserves are estimated to be 4,750,000 short tons of high quality coal. The proximate coal analysis on as received basis and taken from seven samples of mine run coal are listed below. The heating value of the coal recovered in expected to average about 12,000 Btu/lb. with 0.6 percent sulfur and a 9 percent ash content.

| Coal Seam | Moisture % | Ash% | Sulfur % | Carbon % | Volatiles % | Btu |
|---|---|---|---|---|---|---|
| Hiawatha | 4.69 | 8.38 | .57 | 47.28 | 39.64 | 12,517 |

The present size of the operation and the limited reserves suggests that mining will continue in the present manner. Mining will proceed using the room and pillar method, driving entries and rooms on development and pulling pillars on retreat with continuous miners. A belt haulage system will be used to transport coal from underground to the surface facilities.

It is doubtful that longwall mining would justify the capital outlay for a longwall unit. Also, the given geologic conditions and the size of the subject tract further suggests that longwall mining would be uneconomical.

We estimate that a 50 percent recovery rate will be obtained by the room and pillar mining method for the lease tract. Maximum economic recovery will be achieved provided sound and prudent mining practices are followed.

Gordon Whitney

Prepared by

APPENDIX 5-3

BLM APPROVAL R2P2, INCLUDING NEW LEASE (FORMERLY Appendix 3-3, 3-3 (L))

# APPENDIX 3-3

## BUREAU OF LAND MANAGEMENT (BLM)

## APPROVAL OF THE RESOURCE RECOVERY PROTECTION PLAN

## FOR TRACT 2

# United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Moab District
P. O. Box 970
Moab, Utah 84532

3482
U-082996
U-49332
(U-067)

RECEIVED MAY 19 1986
MAY 20 1986

DIVISION OF
OIL, GAS & MINING

Memorandum

To: Senior Project Manager for Utah, Office of Surface Mining, Denver

Attention: Richard Holbrook

From: District Manager, BLM, Moab

Subject: Trail Mountain Mining and Reclamation Plan, Tract 2 (UT 0017)

We have received the subject plan consisting of 2 volumes on April 16, 1986 and have reviewed it with regards to land uses administered by the BLM and the adequacy of the resource recovery and protection plan ($R^2P^2$). The submitted plan is an amendment to the original permit application package (PAP), referenced UT 0017, and approved by the Assistant Secretary on December 14, 1984. Soon after approval, the complete plan on file in our Salt Lake State Office was transferred to the San Rafael Resource Area (in Price, Utah) of the Moab District, where field engineers responsible for on-ground lease administration would have access to the complete plan. It was decided once the mine plan is approved and sent to field offices that any revisions, changes or additions to the $R^2P^2$ would be reviewed and commented on at the District level. We, therefore, are addressing items checked for both the Branch of Solid Minerals (BSM) BLM and Federal Land Managing Agency (FLMA).

The subject tract is entirely on National Forest land requiring no response to land use conflicts and protection of nonmineral resources by the BLM.

With regard to the $R^2P^2$, we have reviewed the mining layout and operational sequencing. Trail Mountain is adding to the original permit a newly acquired emergency Federal coal lease U-49332 located directly west and adjoining the present permit area. All access to the lease will be from adjacent underground mine workings located in the present permit area. Present surface facilities will be used. The plan meets the requirements of the 43 CFR 3482.1(c) rules and regulations. We have determined that the proposed coal recovery procedures will safely obtain maximum recovery of the coal resource within the plan area using the equipment and technology proposed. Within the limits of our authority, we approve the $R^2P^2$ and recommend the subject plan be approved.

/S/ GENE NODINE

cc:
Diamond Shamrock Trail Mountain Coal Co.
DOGM
USO (U-921)

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
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| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 3-3(L)

# B.L.M. APPROVAL OF $R_2P_2$

# FOR

# NEW LEASE AREA

# United States Department of the Interior

## BUREAU OF LAND MANAGEMENT

Moab District
Price River/San Rafael Resource Areas
125 South 600 West
P. O. Box 7004
Price, Utah 84501

3482
U-64375
U-49332
U-082996
(UT-066)

CERTIFIED MAIL - RETURN RECEIPT REQUESTED
Certified No. Z 382 123 785

J. Brett Harvey, President
Interwest Mining Company
201 South Main, Suite 2300
Salt Lake City, Utah 84140

MAR 15 1996

Re: Trail Mountain Mine Resource Recovery and Protection Plan (R2P2), Minor Modification Request; Response to PacifiCorp's Alternative Mine Plan for Trail Mountain Mine

Dear Mr. Harvey:

On January 9, 1996, the Bureau of Land Management (BLM) received PacifiCorp's "Alternative Mine Plan for the Trail Mountain Mine"/Trail Mountain R2P2, dated December 22, 1995. The Alterative Mine Plan was supplemented by an addendum which was originally dated and submitted to the BLM February 1, 1996, and was resubmitted with certain corrections on February 5, 1996. On March 4, 1996, a Settlement Agreement regarding the Trail Mountain R2P2 was achieved. Therefore, in accordance with the March 4 Settlement Agreement, the BLM has determined the proposed resource recovery and protection plan for the Trail Mountain Mine does comply with the Mineral Leasing Act of 1920, as amended, the regulations at 43 CFR 3480, the lease terms and conditions, and the stipulations, and will achieve maximum economic recovery of the Federal coal. Hence, approval of the Trail Mountain Resource Recovery and Protection Plan is granted.

The BLM extends a sincere thanks and appreciation to PacifiCorp for their efforts and professional cooperation in resolving this matter. If you have any questions, please contact Barry Grosely in the Price River Resource Area at (801) 636-3606.

Sincerely,

MARK E. BAILEY

Area Manager

cc: UT-921, SD, Utah
UT-065, DM, Moab
J.R. Key
Director, Technical Services
Interwest Mining Company
201 South Main, Suite 2000
Salt Lake City, Utah 84140-0020
Carl Pollastro
Manager, Technical Services
Energy West Mining Company
15 North Main
Huntington, Utah 84528

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EFFECTIVE:
APR 23 1996
UTAH DIVISION OIL, GAS AND MINING

APPENDIX 3-3L

## SETTLEMENT AGREEMENT

PacifiCorp, by an officer of its authorized agent, Energy West Mining Company, together with its counsel of record, Stoel Rives LLP; and the Bureau of Land Management, acting through its authorized officer, together with Bruce Babbitt, Secretary of the United States Department of the Interior, and all other defendants, acting by and through their counsel of record, the United States Attorney, hereby stipulate to settlement of all issues in the matter now pending in United States District Court for the District of Utah captioned PacifiCorp v. Bruce Babbitt, Secretary of the United States Department of the Interior, et al., Civil No. 2:95CV 0923G, on the following terms:

1. The Bureau of Land Management ("BLM"), acting through its Authorized Officer, will, by written decision, approve, the "Alternative Mine Plan for the Trail Mountain Mine" as submitted by Interwest Mining Company, a subsidiary of PacifiCorp, dated December 22, 1995, as supplemented by an addendum which was originally dated and submitted to the BLM February 1, 1996 and was resubmitted with certain corrections on February 5, 1996. These documents collectively are hereinafter referred to as the "Trail Mountain R2P2." Because the Trail Mountain R2P2 is confidential, it is not attached hereto. PacifiCorp and the defendants each represent to the other that they have in their possession a full and complete copy of the Trail Mountain R2P2 referred to in this Settlement Agreement.

2. The conduct of operations pursuant to the Trail Mountain R2P2 will be subject to all lease terms and regulations governing the conduct of mining operations pursuant to an approved R2P2.

3. In order to accomplish the mining as planned in the Trail Mountain R2P2 in the proposed 4th East and 5th East longwall panels, it will be necessary to conduct full extraction mining operations under a portion of the Castlegate escarpment. Authority to conduct such longwall extraction operations under the escarpment is contingent upon approval by governmental agencies other than the BLM. Therefore, PacifiCorp and the BLM agree that they will each make a good faith effort to obtain all approvals necessary to conduct the planned operations following the sequence and timing set forth in the Trail Mountain R2P2. In the event such approvals are not obtained prior to the time scheduled operations would otherwise occur under the Trail Mountain R2P2, then bleeder and set up entries in the 4th East and 5th East longwall panels shall be established by PacifiCorp at the locations shown in the proposed R2P2 that is the subject matter of the above-captioned litigation. In the event such approvals are not obtained in time to conduct the longwall operation, no royalty will be assessed on coal under and east of the escarpment in the remainder of Area I, as designated on Enclosure "1" to the BLM's letter to PacifiCorp dated September 25, 1995. The line of demarcation will be the angle of draw that would preclude potential adverse impacts to the escarpment.

INCORPORATED
EFFECTIVE:
APR 2 6 1996
UTAH DIVISION OIL, GAS AND MINING

4. In order to accomplish the mining as planned in the Trail Mountain R2P2 in the proposed 6th East longwall panel, it will be necessary for PacifiCorp to obtain from the appropriate governmental agencies a Special Use Permit or other authorization for the development of underground rights-of-way outside the present federal coal lease boundaries. Authority to conduct such operations is contingent upon compliance with environmental laws and may also require the approval of governmental agencies other than the BLM. Therefore, PacifiCorp and the BLM stipulate that they will each make a good faith effort to obtain all approvals necessary to conduct the planned operations in the development and extraction of the 6th East longwall panel as set forth in the Trail Mountain R2P2. In the event compliance with the environmental laws and the obtaining of the necessary approvals does not occur prior to the time scheduled operations would otherwise occur under the Trail Mountain R2P2 in the 6th East longwall panel, PacifiCorp shall not be obligated to conduct the development and extraction operations shown in the Trail Mountain R2P2 with respect to the 6th East longwall panel. In the event such approvals are not obtained in time to conduct the planned operations, no royalty will be assessed upon reserves remaining unmined in the 6th East longwall panel or in the remainder of Area II, as designated on Enclosure "1" to the BLM's letter to PacifiCorp dated September 25, 1995.

5. In order to accomplish the mining as planned and in the sequence approved in the Trail Mountain R2P2 in the proposed 12th Right, 11th Right, 10th Right, 9th Right and 8th Right longwall panels, it will be necessary for PacifiCorp to obtain from the appropriate governmental agencies a Special Use Permit or other authorization for the development of underground rights-of-way outside the present federal coal lease boundaries. Authority to conduct such operations is contingent upon compliance with environmental laws as well as the approval by governmental agencies other than the BLM. Therefore, PacifiCorp and the BLM stipulate that they will each make a good faith effort to obtain all approvals necessary to conduct the planned operations in the development and extraction of the 12th Right, 11th Right, 10th Right, 9th Right and 8th Right longwall panels as set forth in the Trail Mountain R2P2. In the event compliance with the environmental laws and the obtaining of the necessary approvals does not occur prior to the time scheduled operations would otherwise occur under the Trail Mountain R2P2 in the 12th Right, 11th Right, 10th Right, 9th Right and 8th Right longwall panels, then the bleeder entries will be established within the boundary of Federal Lease U-64375, ~~maintaining a 50 ft. (minimum) solid coal external property boundary barrier~~, approximately at the locations shown for the set up entries in the Trail Mountain R2P2. New set up entries for the referenced longwall panels shall be established by PacifiCorp with a barrier pillar design as referred to in the February 5, 1996 addendum. This action and subsequent layout would result in the establishment of a "step" bleeder system along the west end of the longwall panels in this area. The parties acknowledge that this design of a "step" bleeder system could result in the possible loss of some reserves. The parties are willing to share the risk of such a reserve loss to achieve maximum economic



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recovery. In the event such approvals are not obtained in time to conduct the planned operations, no royalty will be assessed upon reserves remaining unmined in the area of the 12th Right, 11th Right, 10th Right, 9th Right and 8th Right longwall panels.

6. Upon execution of this Settlement Agreement, counsel for PacifiCorp and defendants will promptly execute a Stipulation of Dismissal Without Prejudice substantially in the form attached hereto as Exhibit "A." Following issuance of the Order of Dismissal, counsel for PacifiCorp will withdraw its appeal of this matter now pending before the Interior Board of Land Appeals and all issues with respect to the subject matter of this litigation shall be deemed resolved between the parties.

7. This Agreement is a settlement and compromise of disputed claims and shall have no precedential effect with regard to any of the issues resolved by it.

DATED this 4th day of March, 1996.

PacifiCorp, by Energy West Mining Company, its ~~Managing~~ Agent

By: _____
Its: Vice President

Stoel Rives LLP,
counsel for PacifiCorp

_____
John S. Kirkham

Bureau of Land Management

By: _____
Its: Deputy State Director, Natural Resources

United States Department of the Interior, and all other Defendants

_____
Bruce Hill, Special Assistant
U.S. Attorney



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APR 29 1996
UTAH DIVISION OIL, GAS AND MINING

3482
U-082099
U-64375
(U-065c)

Moab District
P.O. Box 970
Moab, Utah 84532

APR 12 1991

Ms. Pamela Grubaugh-Littig
Division of Oil, Gas and Mining
355 West North Temple Street
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

Dear Ms. Grubaugh-Littig:

On August 13, 1990, the Bureau of Land Management (BLM) received a copy of the permit application package (PAP) from your office entitled "Federal Lease Tract Addition, Beaver Creek Coal Company, Trail Mountain No. 9 Mine, ACT/015/009". This PAP requires our response in two areas. Since a portion of the lands applied for are located on BLM surface, a response as to the completeness of post mining land uses and protection of non-mineral resources is required. In a letter to your office dated October 28, 1990, we stated that the PAP is complete in regard to these items. The other area requiring our review is the resource recovery and protection plan (R2P2). Our review is discussed below.

Beaver Creek Coal Company (BCCC) plans to add Federal lease U-64375 to their permit area at the Trail Mountain No. 9 Mine. The mine plan calls for extending the current mine workings south and west into the new lease. All access to this lease will be from existing mine works and no new surface facilities will be constructed. The R2P2 details the planned underground mine workings and extraction (room and pillar) methods for this new lease as required by the mineral leasing laws.

Although complete pillar extraction is contemplated, previous experience at the mine under similar circumstances has not met with success. These circumstances involve mining at depths of around 2000 feet and a massive sandstone strata above the immediate roof that is not conducive to caving. For this reason, the BLM expects to approve several changes until the optimal recovery is obtained.

Lease terms specify protection of cliffs from mine-induced subsidence failure. In reviewing the plan, one planned room and pillar panel falls under the area of influence of potential escarpment failure due to subsidence caused by mining activities. To avoid potential escarpment failure, the last panel on the eastern boundary of T18S, R6E, section 1, will be limited to first mining only in order to leave pillars of sufficient size to prevent caving of the strata (see attached map). With this addition, the plan is adequate and technically complete.

We have determined that the R2P2 is in compliance with the Mineral Leasing Act of 1920, as amended, the regulatory provisions of 43 CFR 3480, Federal lease terms and conditions, and the requirement for achievement of maximum economic recovery of Federal coal. Therefore, we recommend approval of the R2P2 for the new lease.

If you have any questions, please contact Stephen Falk or Gary Johnson in our Price Coal Office at (801) 637-4584.

Sincerely yours,

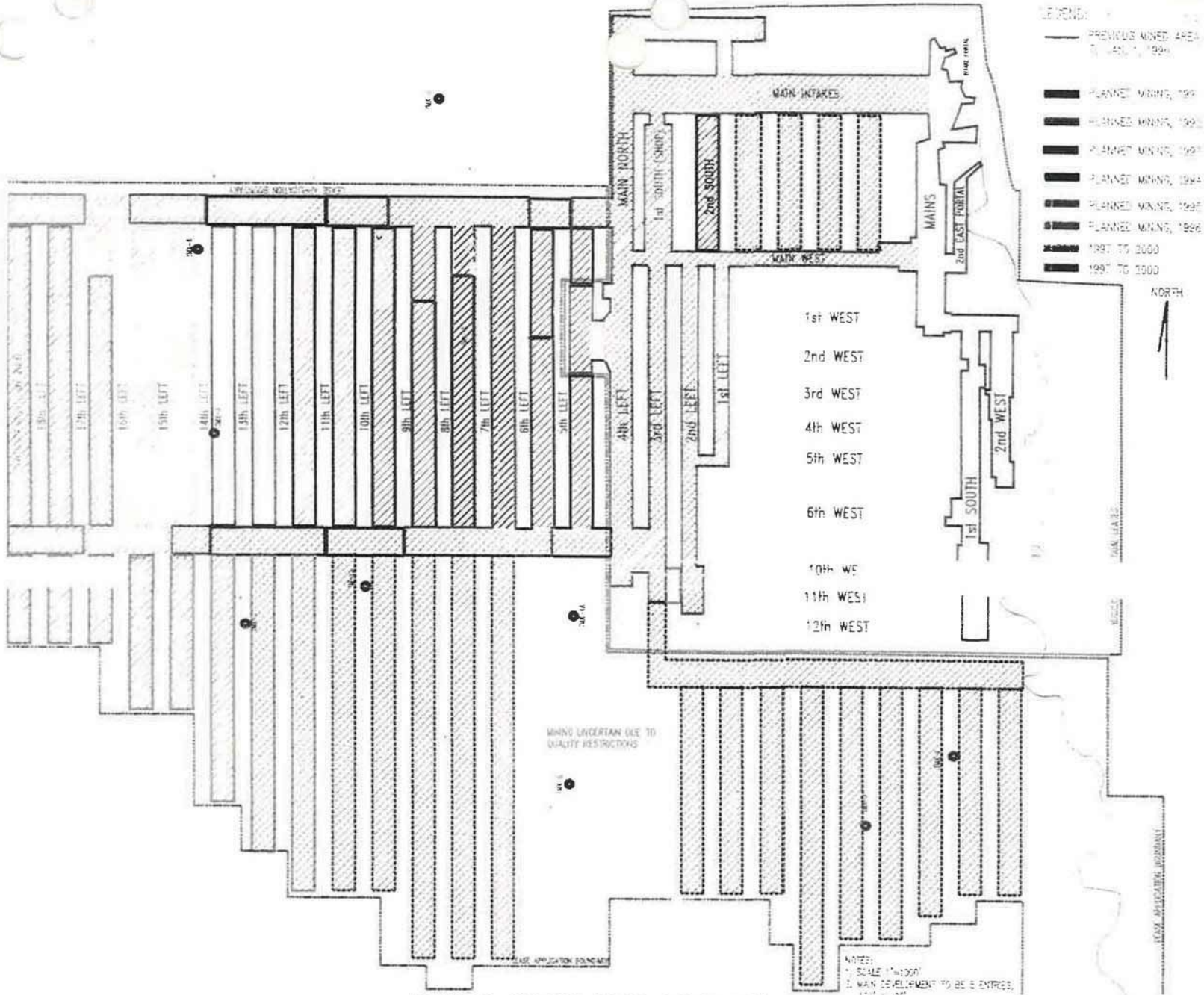
/s/ Gary Johnson

for Assistant District Manager
Mineral Resources

Enclosure:
Projected Mine Map

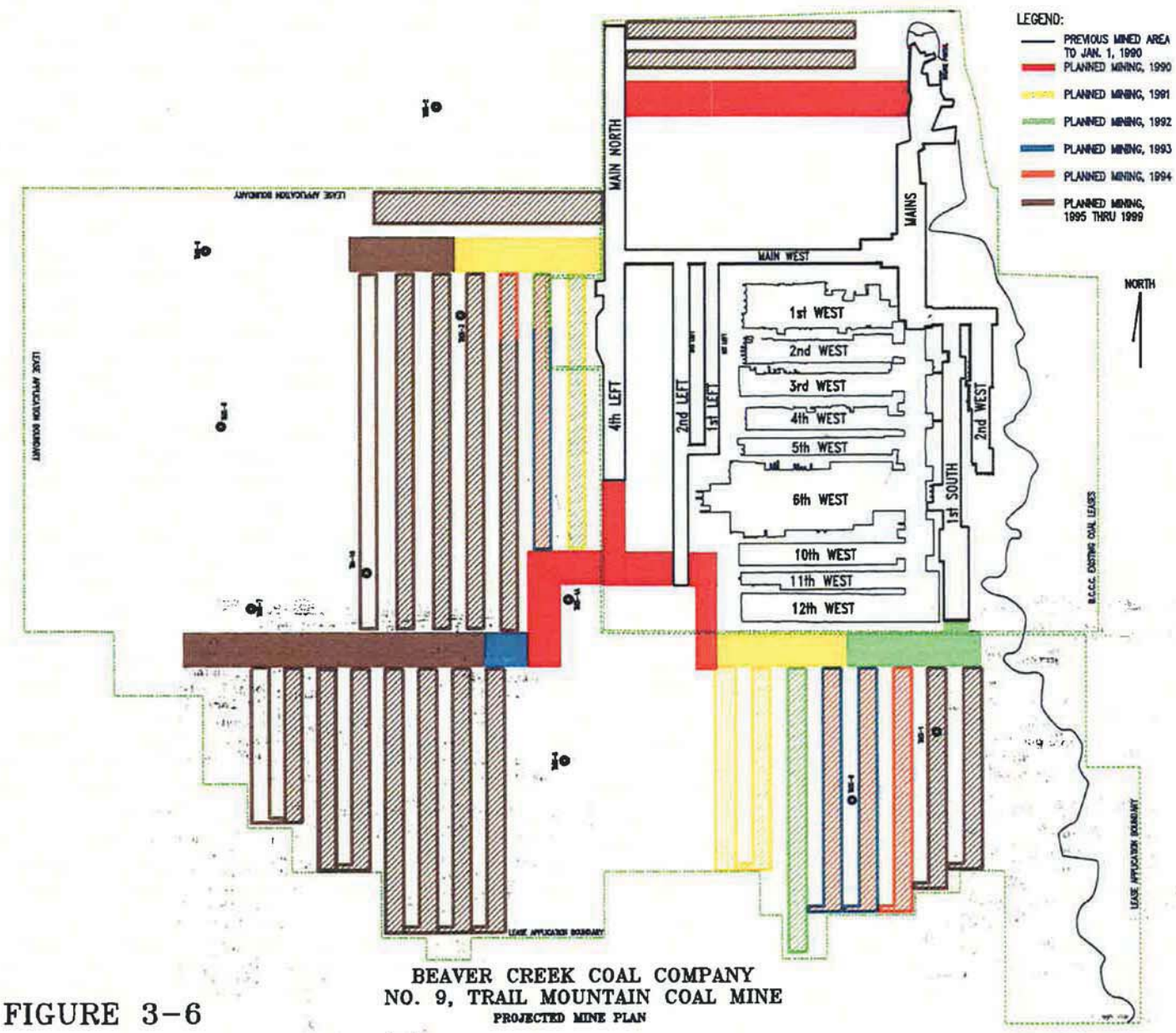
cc: SD, Utah (U-921), w/enclosure
DM, Moab (U-065), w/enclosure
Beaver Creek Coal Company, w/enclosure
Manti-LaSal National Forest, Price, w/enclosure

SFalk:svo:4/12/91
Wang 2067D




BEAVER CREEK COAL COMPANY
NO. 9, TRAIL MOUNTAIN COAL MINE
PROJECTED MINE PLAN, 10/16/91
3 UNIT SHIFT, 5 DAYS, 1 CONTINUOUS HAULAGE

CONFIDENTIAL




BEAVER CREEK COAL COMPANY
NO. 9, TRAIL MOUNTAIN COAL MINE
PROJECTED MINE PLAN

FIGURE 3-6

# APPENDIX 5-3-1

# STABILITY ANALYSIS

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 3-1

## STABILITY ANALYSES

Beaver Creek Coal Company
Trail Mountain No.9 Mine

TABLE OF CONTENTS

Stability Analysis

Existing Highwalls

Post Mining Walls

Fill Areas

Sedimentation

*Slope Stability Analysis of Fill Slope at Station 9 + 00 to 11 + 00
(Slope Reduction July, 1985)

137 West 2260 South, Salt Lake City, Utah 84115 Telephone (801) 487-7754

Delta
GEOTECHNICAL CONSULTANTS INC.

July 5, 1985

Diamond Shamrock
Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537-0370

Attention: Mr. Allen Childs

Subject: Slope Stability Analysis
Fill Slope at Stations 9+00 to 11+00
Trail Mountain Coal Co.
Orangeville, Utah

Delta Job No. 1646

Gentlemen:

Presented in this report are the results of our stability analysis of the fill slope area between approximate stations 9+00 to 11+00 at the tipple area of the Trail Mountain Coal Mine.

SCOPE OF WORK

A slope stability analysis was conducted of a representative cross section of the fill area between approximate stations 9+00 to 11+00. The cross section was prepared by the client and was presented as being representative of the above fill slope area. Recent photos of the fill area were also provided by the client. Our selection of rock and soil parameters utilized in the analysis and site characteristics are based on published data and on previous field investigations of the site. A stability analysis of a fill slope at this site was conducted under a previous report (R & M No. 361080, drawing 3-A). However, the fill material type and slope geometry differ appreciably from the initial analysis and a reevaluation of the slope stability was required.

EXISTING SITE CONDITIONS

The site consists of a 35 to 40-foot high fill comprised of compacted gravel to block-sized rock derived

from the Starpoint sandstone. The fill slope surface slopes at 35 degrees and is approximately equivalent to the steep natural slopes in the area. A 12 to 15-foot wide, 6 to 8-foot high berm is located along the toe of the slope. The berm is comprised of 6 to 8-foot diameter blocks of rock derived from the Starpoint sandstone. The Starpoint sandstone, a massive to thick-bedded sandstone, comprises the base and back slope of the fill area. The original and existing slope geometries are shown on the attached Figure A-1. The Starpoint sandstone dips three to four degrees into the hillside at the site area. The fill slope is well drained due to its granular nature.

ANALYSIS

The analysis was performed using the Swedish circle method of slices. This method ignores inter-slice strength contributions and is thus conservative. The two most likely failure surfaces, based on the site geometry and the soil-rock parameters, are shown on Figure A-1.

A factor of safety of 1.54 was determined for the drained, static condition for the failure surface undercutting the berm (failure surface "A").

A factor of safety of 1.31 was determined for the drained, static condition for the failure surface intersecting the slope just above the berm (failure surface "B").

Soil-rock strength parameters and calculations for the analysis are attached.

We have been pleased to provide this service to you. Please contact us if there are any questions on the above or if we may be of further service.

Very truly yours,

DELTA GEOTECHNICAL CONSULTANTS, INC.

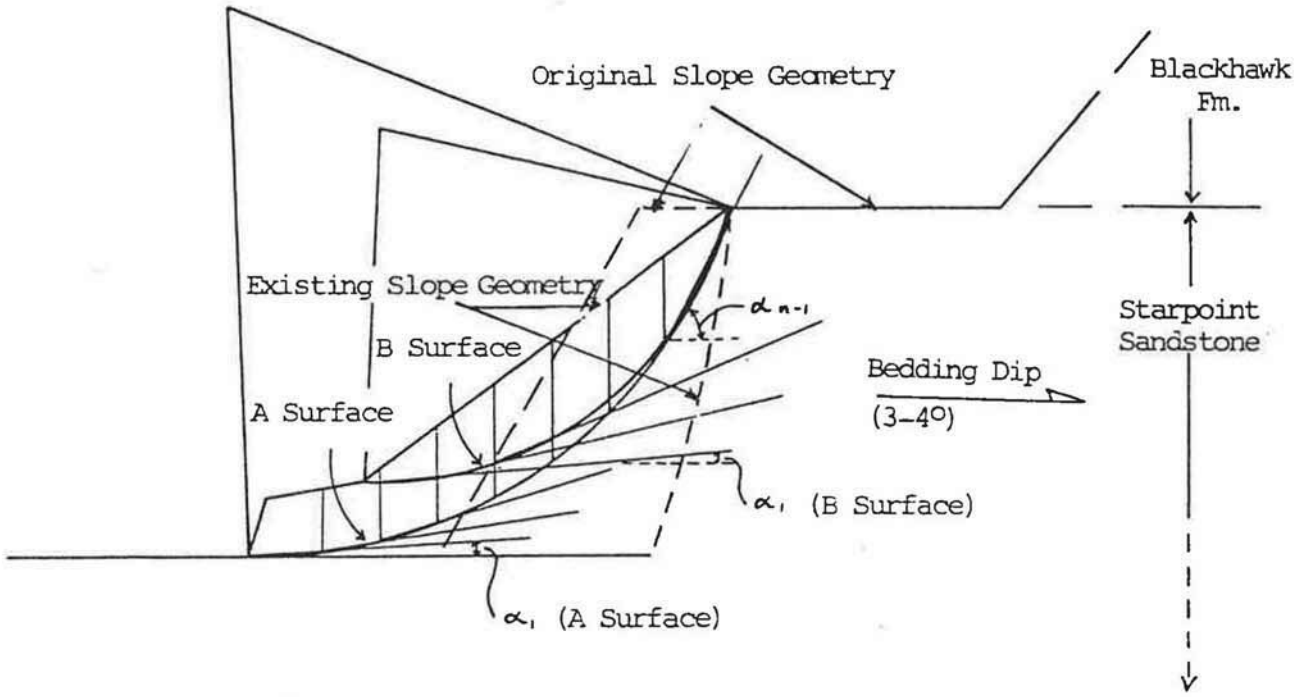
LaMONTE G. SORENSON
Principal Engineering Geologist

Reviewed by:

ANTHONY R. PAWLOSKI, P.E.
Principal Engineer

LGS/amh

Delta




SCALE: 1"=20'

JOB NO. 1646

FIGURE A-1

## SOIL-ROCK PARAMETERS UTILIZED

| | $\gamma$ | $\phi$ | c |
|---|---|---|---|
| Starpoint Ss. | 160 | 45 | 10,000 |
| Fill (Derived from Starpoint Ss) | 120 | 40 | 0 |

$\gamma$ = Unit Weight of Material (pcf)

$\phi$ = Angle of Internal Friction (degrees)

c = Cohesion (psf)

## COMPUTATIONS

"A" Failure Surface

| Slice No. | $\alpha$ | W | T | N | R |
|---|---|---|---|---|---|
| (1) | 4 | 4320 | 301 | 4309 | 3616 |
| (2) | 10 | 4320 | 750 | 4254 | 3570 |
| (3) | 20 | 5400 | 938 | 5074 | 4258 |
| (4) | 27 | 6430 | 2942 | 6197 | 5200 |
| (5) | 31 | 7200 | 3708 | 6172 | 5179 |
| (6) | 39 | 7200 | 4531 | 5595 | 4695 |
| (7) | 48 | 6480 | 4815 | 4336 | 3638 |
| (8) | 62 | 2520 | 2225 | 1183 | 992 |
| | | | | 20210 | 31148 |

$FS = \frac{31148}{20210} = 1.54$

"B" Failure Surface

| Slice No. | $\alpha$ | W | T | N | R |
|---|---|---|---|---|---|
| (1) | -1 | 240 | -4.2 | 240 | 2001 |
| (2) | 5 | 2880 | 251 | 2870 | 2408 |
| (3) | 13 | 5760 | 1296 | 5612 | 4709 |
| (4) | 20 | 6430 | 2216 | 2082 | 1747 |
| (5) | 32 | 7200 | 3815 | 6106 | 5123 |
| (6) | 46 | 6480 | 4661 | 4501 | 3777 |
| (7) | 62 | 2520 | 2225 | 1183 | 993 |
| | | | 14460 | | 18958 |

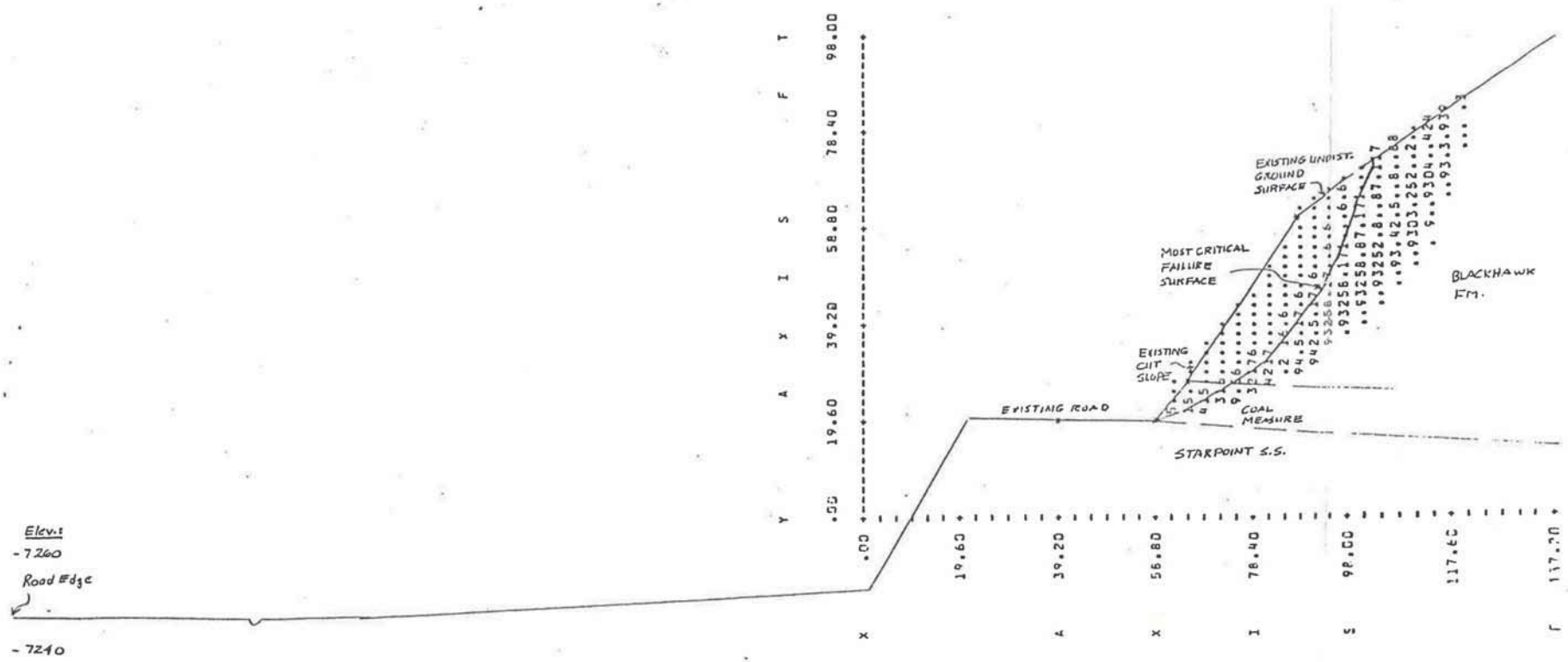
$FS = \frac{18950}{14460} = 1.31$

$\alpha$ = Angle of Base of Slice from Horizontal (degrees)
W = Weight of Slice (pcf)
T = W ($\sin\alpha$) = Total Driving Force
N = W ($\cos\alpha$) = Component of W Normal to Slice
R = N tan $\phi$ = Total Resisting Force
F = Factor of Safety Against Failure = R/T

STA. 3+50-EXISTING SLOPE

Dwg. No. 2

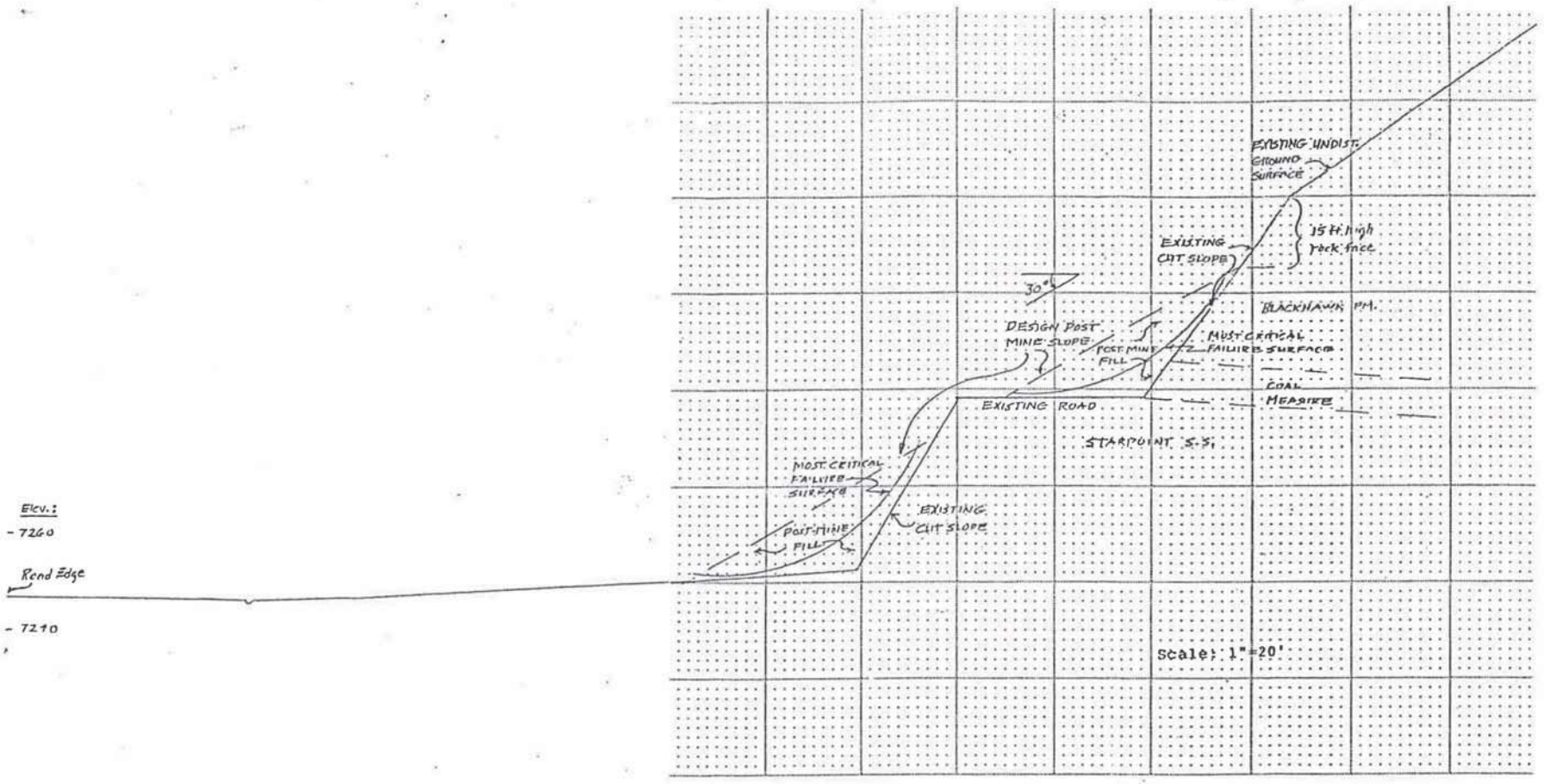
Scale: 1"=10'
EXISTING GROUND SURFACE
BLACKHAWK FM.
COLLUVIUM
EXISTING GROUND SURFACE
STARPOINT S.S.
POST MINE FILL SLOPE (30°)
MOST CRITICAL FAILURE SURFACE
130 ft to Road Edge
(Refer to Dwg. No. 2 for complete site X-section)
STA. 3+50-POST MINE SLOPE
Dwg. No. 2A




Scale: 1"=20'

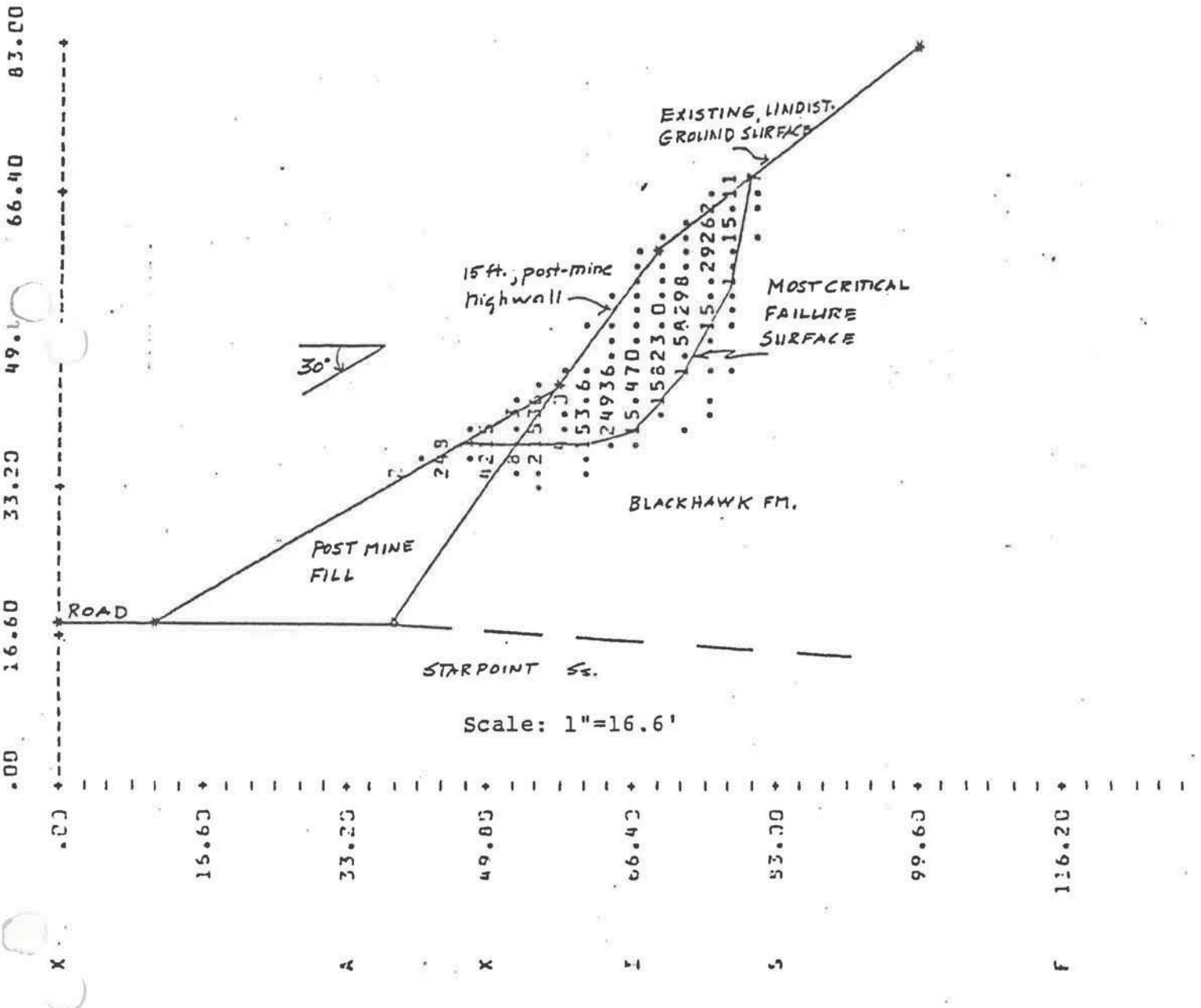
STA. 9+00 = EXISTING SLOPE

Dwg. No. 3




STA. 9+00 - POST-MINE SLOPES

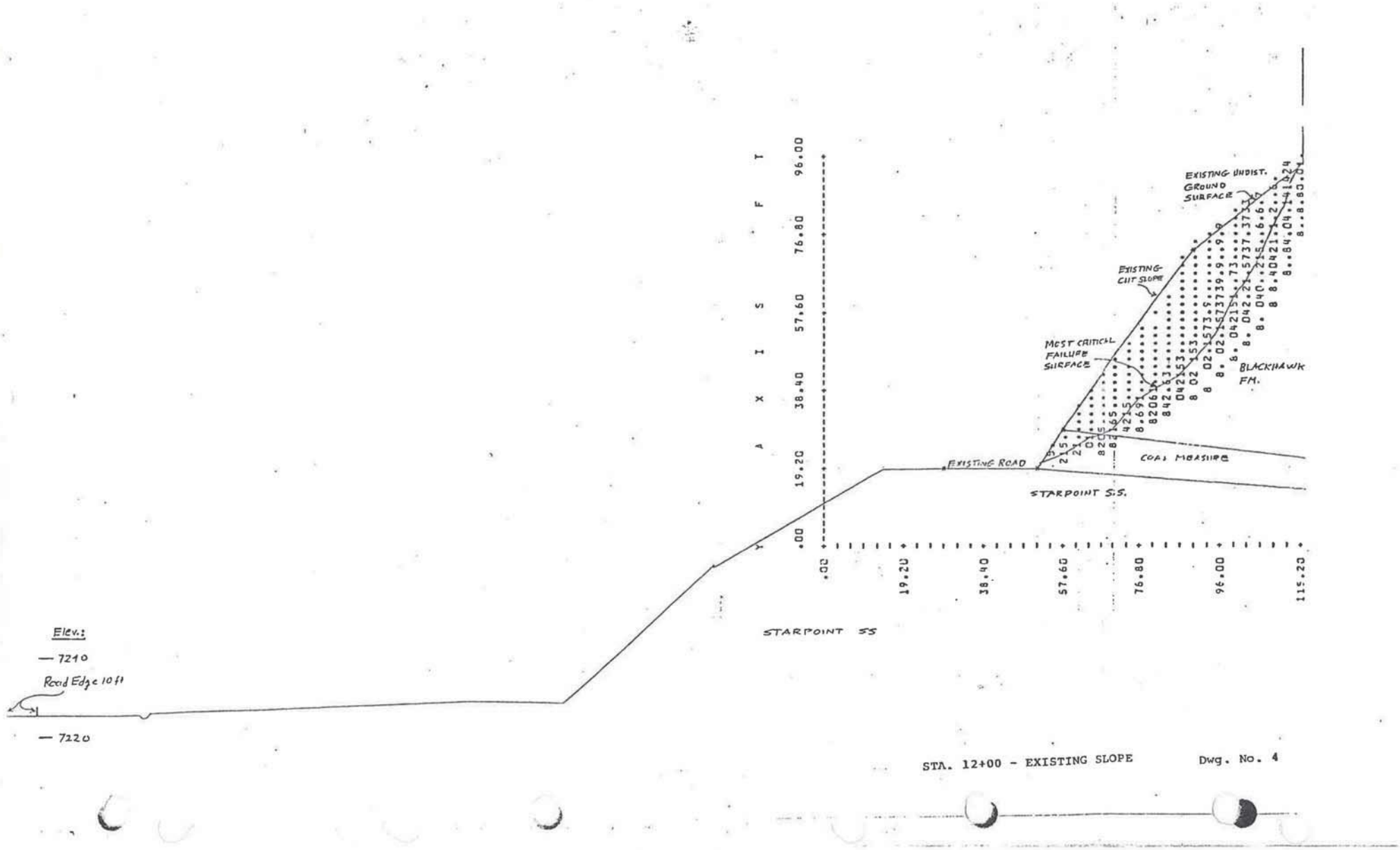
Dwg. No. 3A



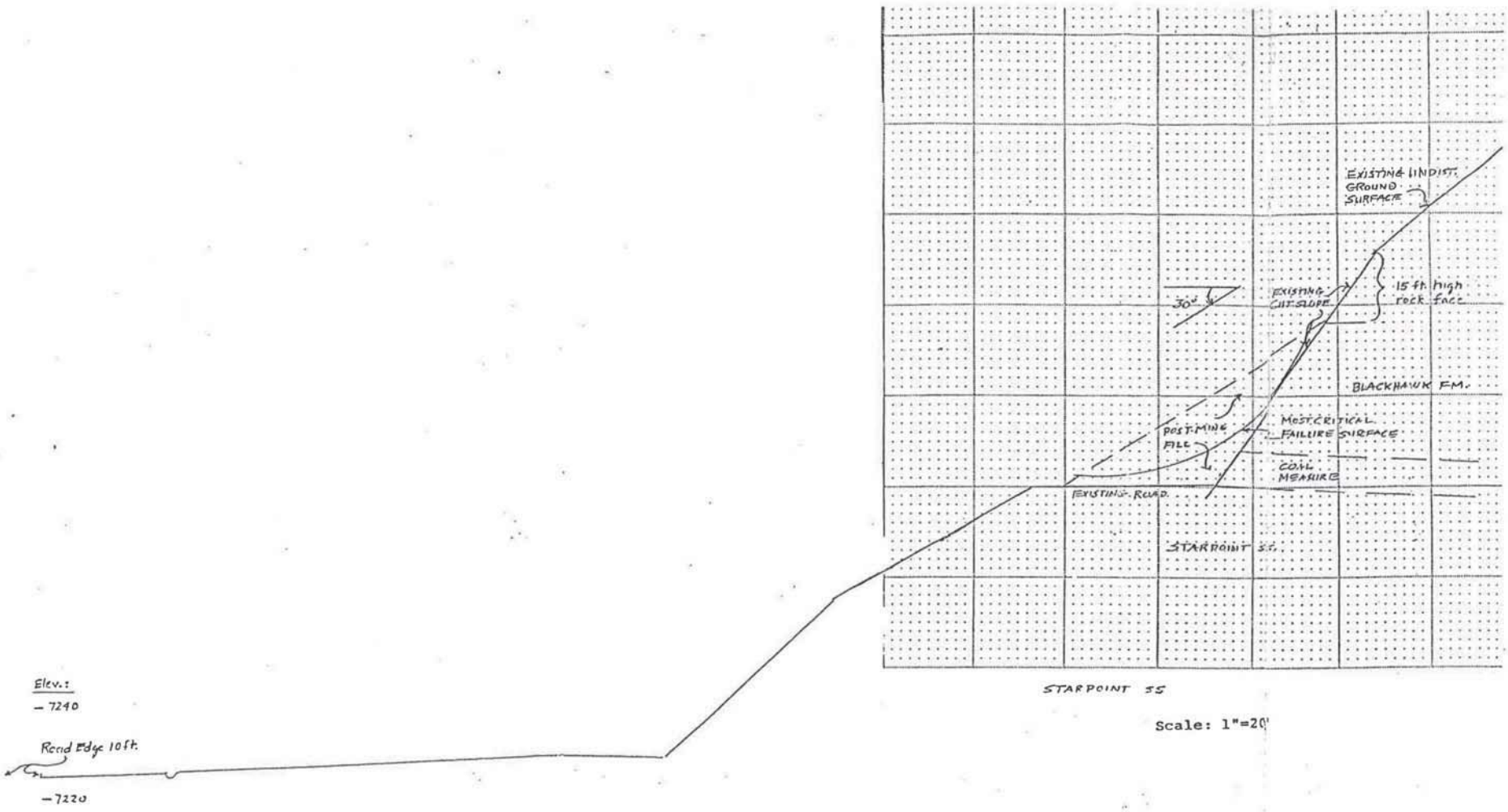

Scale: 1"=16.6'

STA. 9+00 HIGHWALL PORTION-POST MINE SLOPE

Dwg. No. 3B



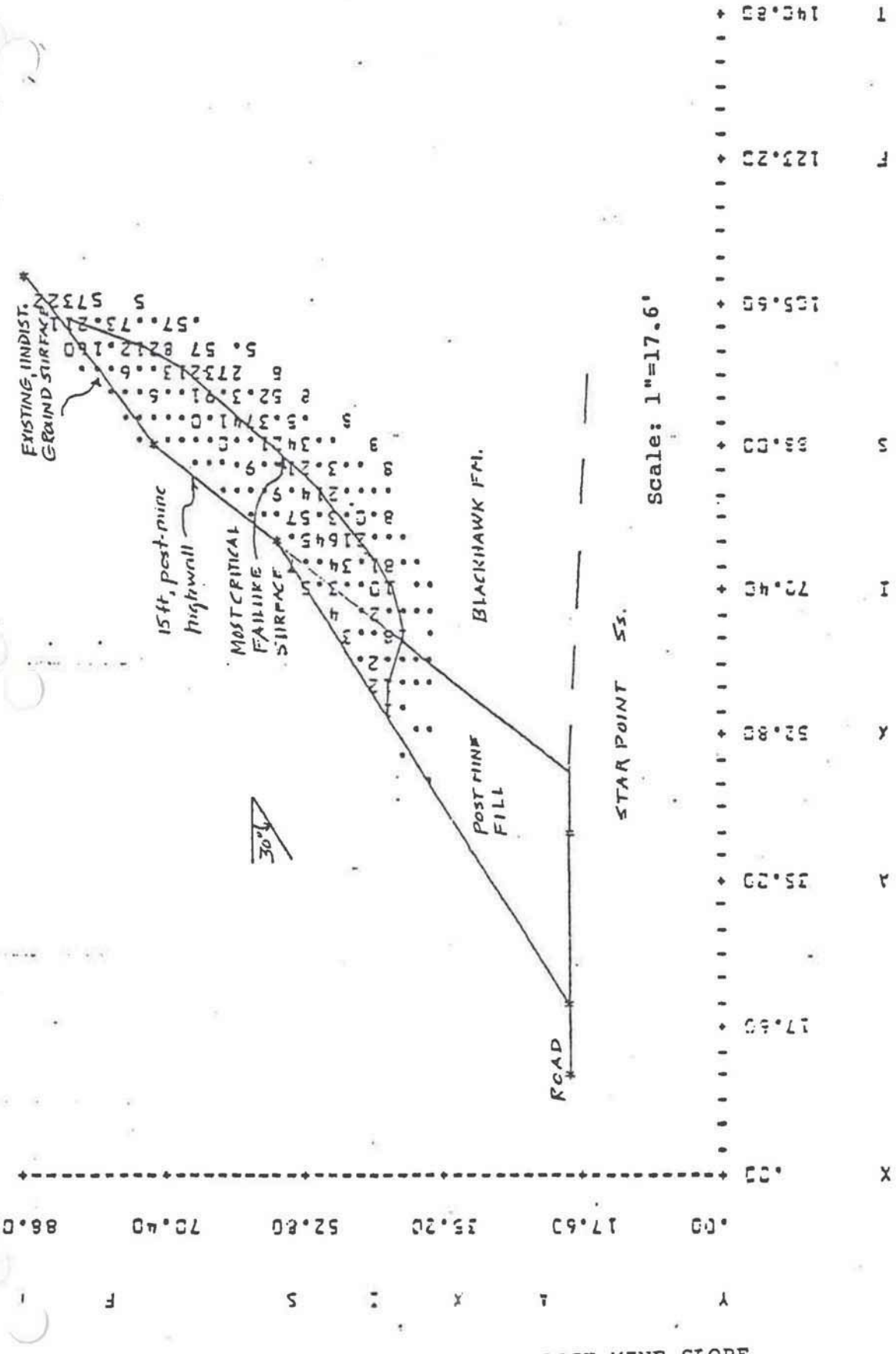

STA. 12+00 - EXISTING SLOPE Dwg. No. 4




STARPOINT SS

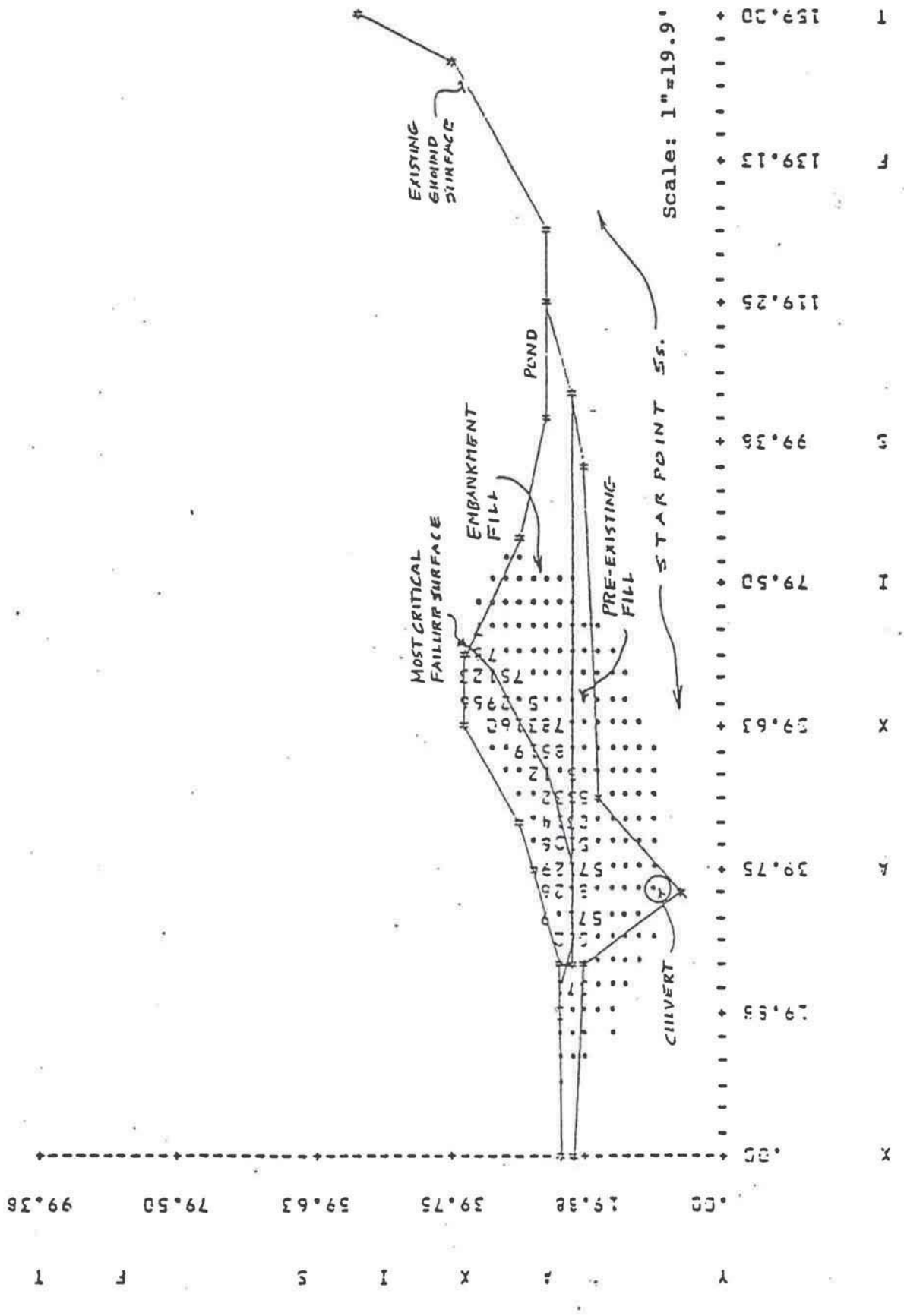
Scale: 1"=20'

STA. 12+30 - POST-MINE SLOPE Dwg. No. 4A




STA. 12+00 HIGHWALL PORTION-POST MINE SLOPE

Dwg. No. 4B




SEDIMENTATION POND - DRY WITH EQ. LOADING

Dwg. No. 5

SEDIMENTATION POND - FULL WITH EQ. LOADING

Dwg. No. 5A

VICINITY MAP
TRAIL MOUNTAIN COAL COMPANY
RSM CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS
DWN
CKD LS
DATE 12/5/83
SCALE 1" = 25'
FB
DWG
PROJ NO 361
DWG NO 1
N
Indicates lateral extent of 10-20 ft high post-mine, remnant highwalls.
8.8 ACRES DISTURBED
UNDISTURBED
STORAGE
BORROW AREA
PARKING
ACCESS
MINE OFFICE
PUBLIC ROAD
FAN
PORTAL
ROAD
COAL STOCKPILE
TIPPLE
SCALE HOUSE
SEDIMENT POND
DUMP
FOOD CREEK
0-60
3-80
7-00
8-00
12-00
17-00
7350
7340
7330
7320
7310
7300
7290
7280
7270
7260
7250
7240
7230
7220
7210
7200
7190
7180
7170

# STABILITY ANALYSIS

R&M CONSULTANTS, INC. BUSCH PARK • 5280 SOUTH 320 WEST, SUITE E-160 • MURRAY, UTAH 84107 • PHONE (801) 263-3419
ENGINEERS
GEOLOGISTS

December 9, 1983

Mr. Allen Childs
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537

Dear Mr. Childs:

Subject: Stability Analyses of Existing and Post-Mining Highwalls and Related Fills and Sedimentation Pond, Trail Mountain Mine Facilities Area

Included herein are three copies of the slope stability analyses of the above site.

We have appreciated the opportunity of providing these goetechnical services to you on this project. Please contact us if you have any questions concerning this report.

Sincerely,

R&M CONSULTANTS, INC.

Larry Migliaccio, P.E.
Manager

LM/ljp

## I INTRODUCTION

Presented below are the results of stability analyses of three existing highwalls, stability analyses of these same areas in the design postmining condition, and stability analyses of an existing sedimentation pond, located on mine lease property of Trail Mountain Coal Company, Emery County, Utah.

This report has been prepared in accordance with an agreement between Trail Mountain Coal Company, Orangeville, Utah and R&M Consultants, Inc., Salt Lake City, Utah.

## II SCOPE OF WORK

The scope of work consisted of computer analyses, to determine factors of safety against failure by mass sliding, of three existing highwalls, or slopes, cut into the Blackhawk Formation. The three areas, located at Stations 3+50, 9+00 and 12+00 (Drawing No. 1), are considered representative of the highwalls in this portion of the mine lease area. The three highwalls each slope at 0.7H:1V with heights of 34 feet, 42 feet and 50 feet, respectively. These same areas were also analyzed to determine factors of safety against sliding in their design, post-mine condition. Both computer analysis and the use of published circular failure charts were used for the post-mine condition, as determined by measured site geometry. The post-mine

condition is to consist of backfilling of these highwall areas, using on-site borrow, to the approximate original ground surface at a final slope of approximately 30 degrees. The backfill is to be compacted to a density approximately equivalent to the undisturbed natural soil density. The fill will extend to the top of the cut area at Station 3+50 and will extend to a point approximately 15 feet below the top of the existing highwalls at Stations 9+00 and 12+00. The lateral extent of the design post-mine remnant highwall areas are shown on Dwg. No. 1.

The 16-foot high sedimentation pond embankment, located at Station 17+00 (Drawing No. 1), was analyzed for factors of safety against failure under dry pond and full pond conditions, with dynamic load conditions assumed. The embankment consists of engineered fill of on-site borrow. Approximately one-half of the sedimentation pond (upstream portion) is underlain by the Starpoint Sandstone. The downstream portion is underlain by pre-existing fill of on-site borrow.

Geometry of the areas investigated was provided by Trail Mountain Coal Company. Field investigations and laboratory testing were not included in the scope of work. Rock and soil strength parameters were determined on the basis of previous field investigations and laboratory testing, conducted by R&M Consultants, Inc. in the mine lease area, results of laboratory testing provided by others, and site-specific photographs and verbal information provided by the client.

## III EXISTING AND DESIGN POST-MINING SLOPE CONDITIONS

The major portion of the existing cut slopes investigated are located in closely-jointed (6- to 14-inch spacings) thin-bedded sandstones, siltstones and shales of the Blackhawk Formation. This formation also includes an eight-foot thick section of coal measures at the base of each of the highwall areas analyzed. The joint openings are up to 1/4 inch wide and filled with stiff to hard clay. Joint orientations are essentially normal to the bedding planes. The Blackhawk Formation at Station 3+50, is covered by a thin wedge of colluvium, as shown on the appropriate attached drawing. The Blackhawk Formation is immediately underlain by massive sandstone of the Starpoint Ss., which is jointed into two- to five-foot wide blocks. Based on published information on the mine lease area, inspection of site specific photographs and previous experience in the area, a uniform bedding attitude striking N20$^{o}$W and dipping 3$^{o}$ to 5$^{o}$SW was assumed for each of the areas analyzed.

Existing or evidence of previous cut slope instability (mass slide movement) is not known to exist within this portion of the mine lease area (west side of drainage) within the Blackhawk Formation. Toppling failure of the massive Starpoint Ss. is also not known to occur within this portion of the mine lease area due, presumably, to the bedding plane attitude (i.e. beds dip into the slopes) which essentially negates this type of failure mode in this area. Bedding plane failures are also not known to occur in this portion of the lease area for the same reason above. Local occurrences of rockfall of massive sandstone blocks, derived from cliff forming sand-

stones in the Blackhawk Formation and/or the Castlegate Ss. occurring well above the cut areas, do occur in this portion of the lease area. These rockfall occurences are neither directly or indirectly related to mine activities but are apparently due to undercutting by natural erosion processes of immediately underlying, less resistant sedimentary beds.

STATION 3+50

A) Existing Highwall

Geometry of the 34-foot high existing highwall is shown on Drawing 2. A layer of colluvium of silty, clayey sand with rock overlies the Blackhawk Formation and coal measure section at this site. The ground surface at the base of the highwall consists of the Starpoint Ss. Bedding plane attitudes and joint spacing and characteristics of the Blackhawk Formation are as described above. Ground water, perched water or springs are not known to occur at this site or general area.

B) Design Post-Mining Fill Slope

Design post-mining slope geometry is shown on Drawing 2A. Compacted fill, derived from on-site borrow, will extend from the top of the existing highwall with a final, easterly slope of 30 degrees.

STATION 9+00

A) Existing Highwall

Geometry of the 42-foot high existing highwall is shown on Drawing 3. The highwall, cut into the Blackhawk Formation, terminates at its base on a mine haul road, located on the Starpoint Ss. Ground water, peched water or seeps are not known to occur at this site or general area.

B) Design Post-Mining Fill

Design post-mining slope geometry is shown on Drawing 3A. Compacted fill, derived from on-site borrow, will extend to a point approximately 15 feet below the top of the existing highwall which is located in the Blackhawk Formation and to a point 10 feet from the edge of a mine development road which is located on the Starpoint Ss. The post-mine fill will slope at approximately 30 degrees easterly.

STATION 12+00

A) Existing Highwall

Geometry of the 50-foot high existing highwall is shown on Drawing 4. The highwall, which is cut into the Blackhawk Formation, terminates at its base on a mine development road which is located on the Starpoint Ss. Ground water, perched water or springs are not known to occur at the site or general area.

B) Design Post-Mining Fill Slope

Geometry of the post-mine slope is shown on Drawing 4A. Compacted fill, derived from on-site borrow, will extend to a point 15 feet below the top of the existing highwall and will slope at 30 degrees easterly.

## IV SOIL AND ROCK STRENGTH PARAMETERS

Assumptions were made of the physical parameters of the soil and rock units involved in the stability analyses. These assumptions were based on previous field experience by R&M Consultants, Inc., in the mine lease area which consisted of outcrop mapping, inspection of natural and existing cut slopes, test pit excavations and laboratory testing (Ref. No. 1). Soil parameters of existing fill material in the mine lease area, derived obtained from on-site grading activities, were based on laboratory test results of samples of this material obtained from test pits excavated to depths of up to 12.0 feet. The tests were performed by Brigham Young University, Department of Agronomony and Horticulture. This material is to be used for post-mine backfill of the present cut slope areas. The average grain size analysis for these samples indicates: gravel (<3in.) - 10%, sand - 48%, silt - 22% and clay - 20%. A moist unit weight of 105 pcf was used for the post-mine fill for the high wall areas with an assumed moisture content of 10%. A soil weight of 105 pcf is equivalent to 80 to 85 percent of Standard Proctor density of 115 to 120 pcf. The physical parameters of the highwall slopes investigated were based on published data (Refs. 2 and 3) regarding rock types equivalent to the Blackhawk Formation, coal measures within the Blackhawk Formation and the Starpoint Ss., and on-site specific photographs and verbal descriptions provided by the client.

Physical parameters of the soil and rock units used in the analyses are as follows:

| | $\gamma_m$ (pcf) | $\gamma_s$ (pcf) | $\phi$ (degrees) | c (psf) | c'(psf) |
|---|---|---|---|---|---|
| Colluvium | 115 | --- | 30 | 750 | --- |
| Pre-existing Fill | 105 | 115 | 30 | 500 | 200 |
| Post-Mine | 105 | --- | 30 | 300 | --- |
| Embankment Fill | 125 | 130 | 35 | 500 | 200 |
| Blackhawk Fm. | 130 | --- | 35 | 500 | --- |
| Coal Measure | 110 | --- | 40 | 500 | --- |
| Starpoint Ss. | 160 | --- | 45 | 10,000 | --- |

Where $\gamma_m$ = Moist unit weight of material (pcf).

$\gamma_s$ = Saturated unit weight of material (pcf).

$\phi$ = Angle of internal friction (degrees).

$c$ = Cohesion in moist condition (psf).

$c'$ = Cohesion in saturated condition (psf).

## V ANALYSES

### A) EXISTING CUT SLOPES

Stability analyses of the existing cut slopes were performed using the STABLE2 Computer Program, developed by Purdue University. STABL2 offers a variety of failure modes and utilizes the Modified Bishop Method with limiting equilibrium procedures to determine factors of safety. One hundred potential failure surfaces are generated by the program with the 10 most

critical presented as the graphical output of the analyses.

The analyses of the existing cut slopes concerned the Blackhawk Formation only. Quantitative analyses of the Starpoint Ss. were not performed since only toppling or plane sliding failure modes are considered possible within this unit and, due to its massive characteristics and the site specific geometry, (i.e. bedding plane attitudes) these failure modes occurrences are highly unlikely.

A circular mode of failure was determined as the most likely failure occurrence within the Blackhawk Fm. due to the closely spaced jointing of the rock units relative to the cut height and lack of continuous planes or discontinuities which would promote a plane sliding or block failure mode.

Results of the analyses are shown on the attached Drawings 2, 3 and 4 with the most critical failure surface of each indicated.

B) DESIGN POST-MINING FILL SLOPES

The STABL2 program was utilized for the post-mine fill slope which had the most critical geometry regarding potential slope instability (Station 3+50). The remaining post-mine fill slopes were analyzed using published circular failure charts for homogenous materials in the drained condition (reference 3). The post-mine fill at Station 3+50 was also analyzed using the circular failure charts with a resultant, relatively close agreement in the factor of safety as determined by both methods.

Results of the analyses are shown on the attached Drawings 2A to 4A, with the most critical failure surface of each indicated.

C) DESIGN POST-MINING HIGHWALLS

Remnant highwalls, left after post-mining fill has been placed, were analyzed by the STABL2 program using a random search to determine the most critical failure surface and minimum factor of safety. This search method was used due to the near-vertical boundary of soil and rock between the initiating and terminating areas of the most likely failure surface. Two of the three highwall areas analyzed (Sta. 9+00 and Sta. 12+00) will have remnant highwalls of approximately 15 feet and are considered representative of the remnant highwalls to be left after reclamation.

Results of the analyses are shown on Dwg. Nos. 3C and 4C, with the most critical failure surface of each indicated.

D) SEDIMENTATION POND EMBANKMENT

The sedimentation pond embankment was analyzed by the STABLE2 program under dry pond conditions, with a horizontal acceleration of 10 percent of gravity assumed, and under full pond conditions with the 10 percent horizontal acceleration also assumed. These represent the worst case conditions and thus, static dry pond, static full pond and rapid drawdown conditions were not analyzed.

Results of the analyses are shown on Drawings 5 and 5A with the most critical failure surface of each indicated.

Results of the stability analyses of all areas investigated are presented on Table 1. Computer documentation of the analyses are on file at

R&M Consultants, Inc., Salt Lake City, Utah, and are available for inspection on request.

## VI COMMENTS AND RECOMMENDATIONS

1. The above analyses for the post-mining fill slopes assume that protection of this fill at the bases of the exposed highwalls will be provided to control surface runoff waters from the highwalls.

2. The post-mine fill should be placed in loose lifts not to exceed two feet in thickness and compacted to 80 to 85 percent Standard Proctor density in order to approximate equivalent undisturbed soil conditions and to stabilize the fill mass. Rocks in excess of 18 inches in maximum diameter should not touch and care should be exercised such that no voids are left in the fill, particularly next to large rocks. The top one and one-half to two feet of the fill may be left in a generally loose condition to facilitate revegetation.

## VII CLOSURE

The contents of this report are based upon both site specific and generalized information, published data and certain qualified assumptions as discussed above. If conditions depart appreciably from those presented in this report, R&M Consultants, Inc. should be notified.

Sincerely,

R&M CONSULTANTS, INC.

LaMonte G. Sorenson,

Senior Engineering Geologist

Larry D. Migliaccio, P.E.

Manager

LS/LM;ljp

# REFERENCES

1. Cottonwood Canyon Alignment-Pavement Design and Slope Stability Studies, R&M Consultants, Inc., Salt Lake City, Utah, 1983

2. Landslides - Analysis and Control, Special Report 176, National Academy of Sciences, Washington D.C., 1978.

3. Hoek, E. and Bray, J. W., 1977, Rock Slope Engineering, Institution of Mining and Metallurgy, London, England.

4. STABL - Computer Analysis of General Slope Stability Problems, Siegel, R.A./Joint Hwy. Res. Proj., Engr, Exp. Station, Indiana State Hwy. Comm/ Purdue Univ., 1975.

# APPENDIX 2

# TABLE 1

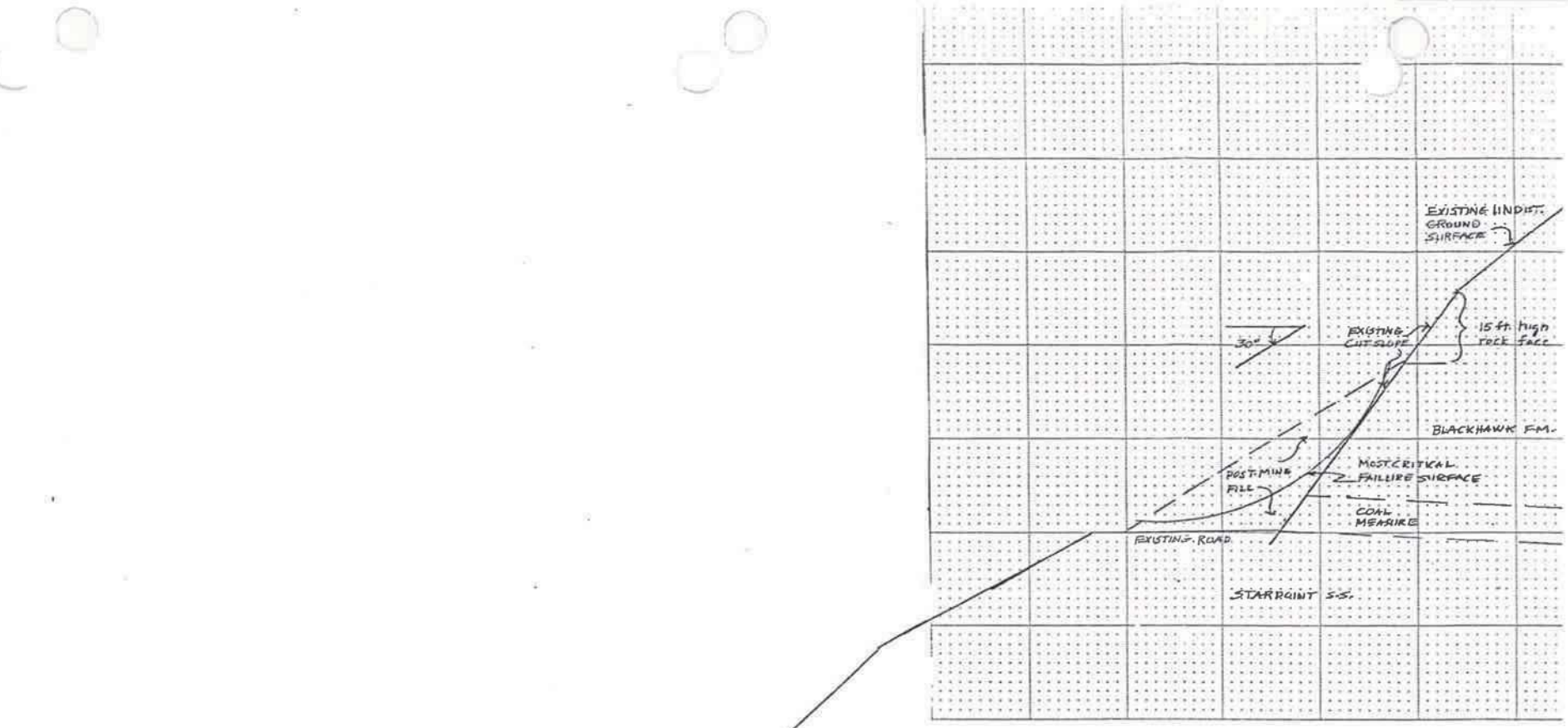
## MINIMUM FACTORS OF SAFETY AGAINST SLOPE FAILURE: Existing Highwalls; Post-Mine Fill Slopes; Post-Mine Highwalls and Sedimentation Pond

### HIGHWALL AREAS:

| | EXISTING HIGHWALLS | POST-MINE FILL SLOPES | POST-MINE HIGHWALLS |
|---|---|---|---|
| Sta. 3+00 | 1.68 | 2.03 | NA* |
| Sta. 9+00 | 1.50 | 2.50 (upper fill areas) | 2.16 |
| Sta. 12+00 | 1.34 | 2.3 | 2.0 |

### SEDIMENTATION POND:

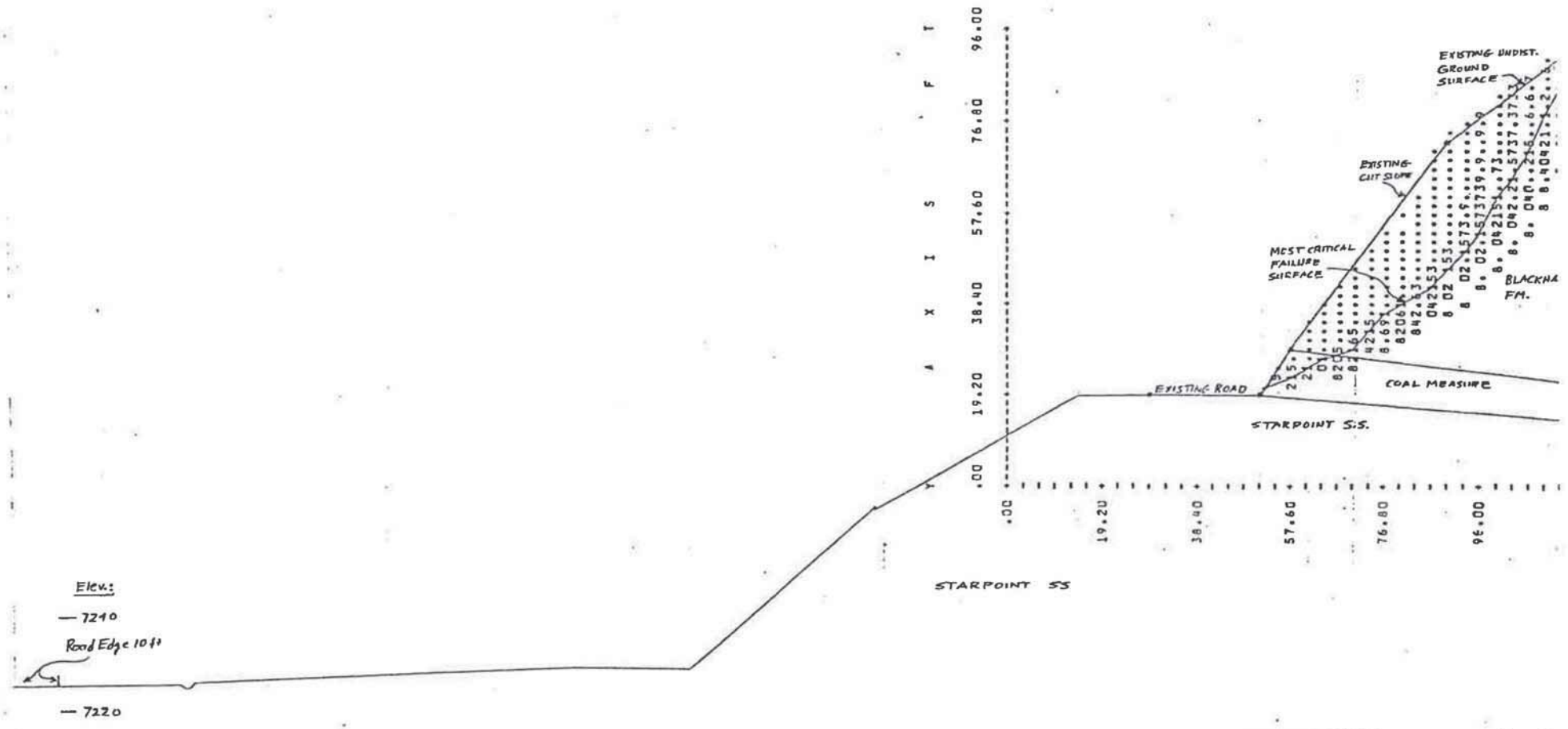
| | DRY POND WITH EARTHQUAKE | FULL POND WITH EARTHQUAKE |
|---|---|---|
| Sta. 17+00 | 3.43 | 2.38 |



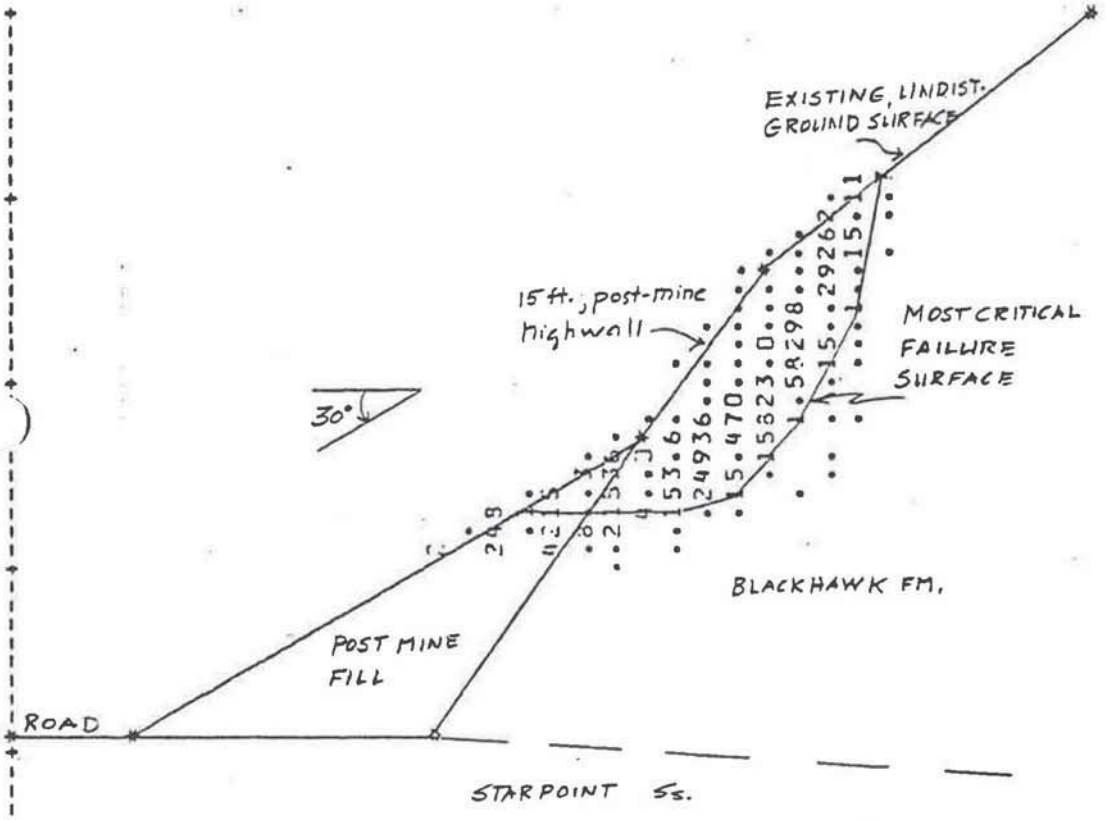

STARPOINT SS

Scale: 1"=20'

STA. 12+00 - POST-MINE SLOPE Dwg. No. 4A



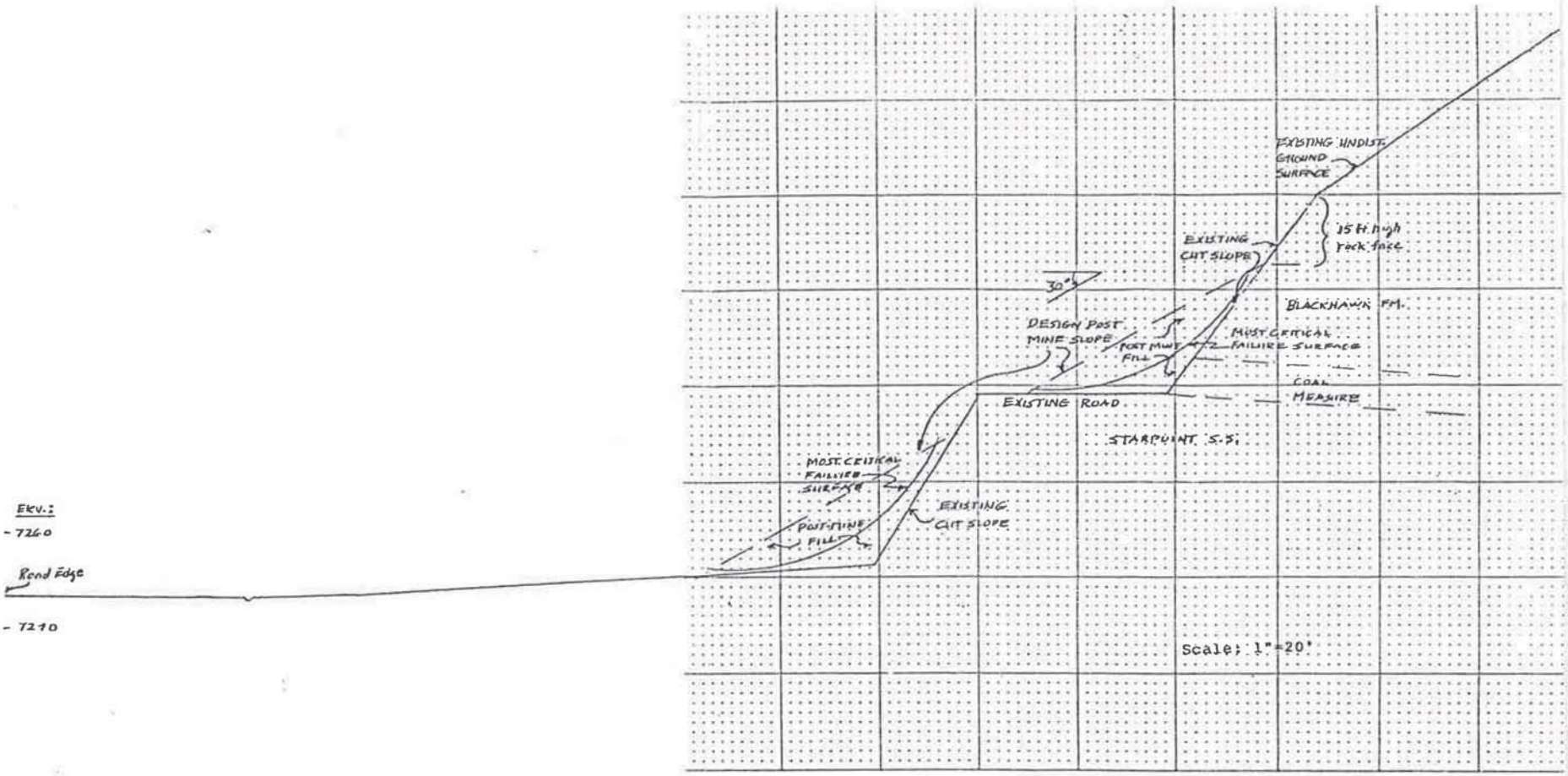

STA. 12+00 - EXISTING SLOPE Dwg. No. 4




Scale: 1"=16.6'

STA. 9+00 HIGHWALL PORTION-POST MINE SLOPE

Dwg. No. 3B

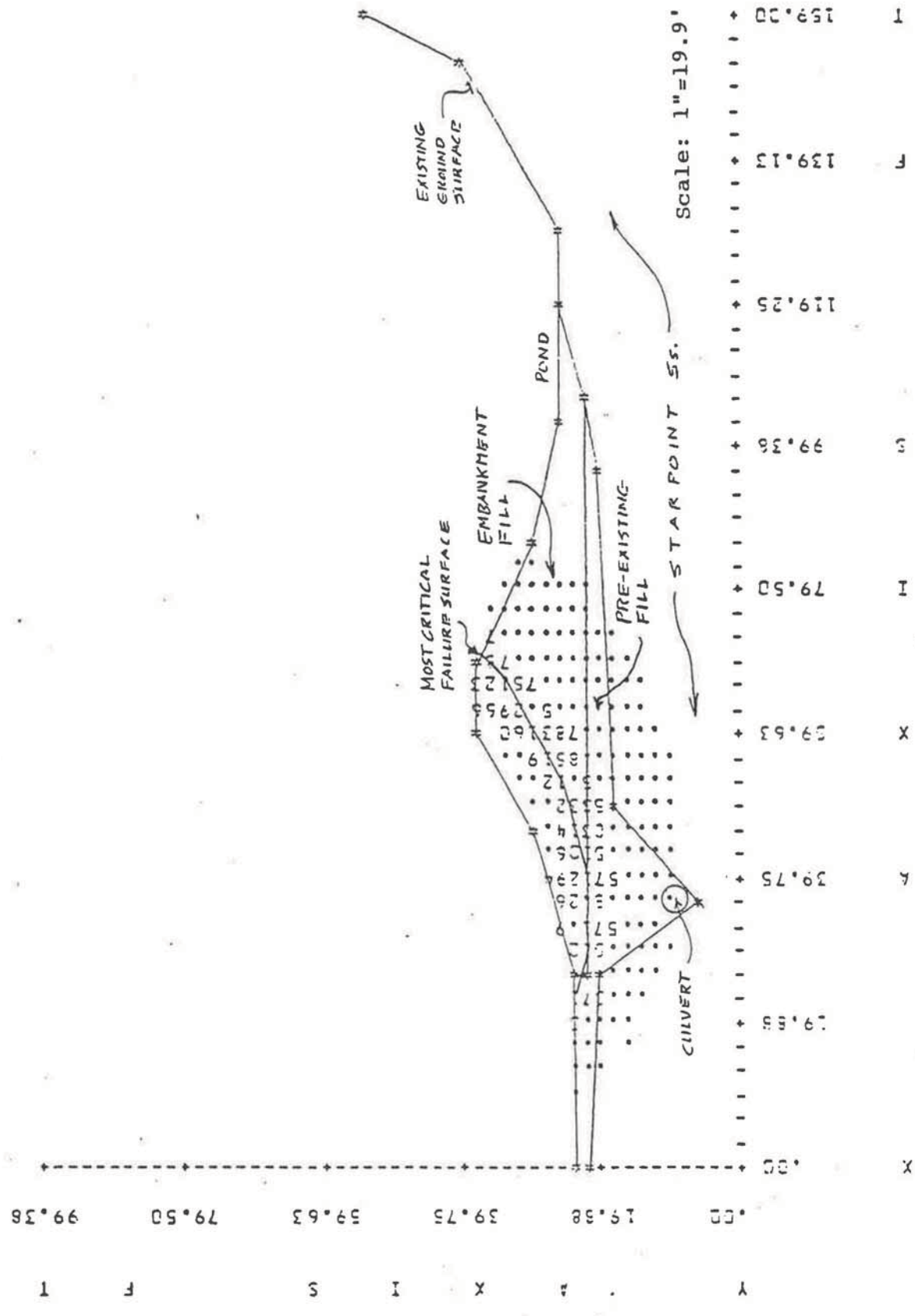



STA. 9+00 – POST-MINE SLOPES

Dwg. No. 3A

STA. 12+00 HIGHWALL PORTION-POST MINE SLOPE

Dwg. No. 4B




SEDIMENTATION POND - DRY WITH EQ. LOADING

Dwg. No. 5

SEDIMENTATION POND - FULL WITH EQ. LOADING

Dwg. No. 5A

APPENDIX 5-4

OPERATION PLAN FOR EXISTIN STRUCTURES (FORMERLY APPENDIX 3-4)

# APPENDIX 3-4

# OPEATION PLAN

# FOR

# EXISTING STRUCTURES

**PacifiCorp**
**Trail Mountain Mine**

**Operation Plan for Existing Structures**

**The following is a list of major structures associated with this operation. All structures are shown on Figure 3-1.**

(a) **Office, Warehouse and Shop Complex - This is a block, 2-story structure which houses the mine offices upstairs, and a warehouse and shop facility on the ground floor. The building was constructed in 1976 and modified up until 1981.**

(b) **Bathhouse - The bathhouse was moved from the Mountain Coal Company Gordon Creek No. 8 Mine in the fall of 1990. This is a single story bathhouse, equipped to serve approximately 125 people. The building lies directly north of the Office/Warehouse/Shop complex.**

(c) **Substation - The substation is an open structures protected by a 6' chain link fence. The structure is constructed, operated and maintained in compliance with applicable MSHA and electrical codes. The substation was constructed in 1980. All transformers in the station have been checked and are non-PCB. An EPA inspection for PCB was conducted in early 1988, and confirmed the compliance of the substation and other transformers on the site.**

(d) **Fan Control House - The existing fan was removed in 1993 and a new fan was constructed in 1993 and 1994 (see Appendix 3-10).**

(e) Coal Handling and Loadout System - This system was installed in late 1990 - early 1991. The old tipple was removed at that time. The system consists of the following major components:

(1) Magnet to remove metal;

(2) Flop-gate on main conveyor to by-pass chute;

(3) By-pass chute, used in the event of system malfunction or bin overflow;

(4) 55' Conveyor to Crusher transfer;

(5) Crusher;

(6) 145' Conveyor to Bin;

(7) 600 Ton Truck Loadout Bin;

(8) Truck Scales;

(9) Control House

The system is equipped with sprinklers to control dust. All conveyors and transfer points are enclosed.

(f) Sediment Control Facilities - The main sediment control facilities on the site consist of the following:

(1) 66" diameter culvert beneath the mine site to carry undisturbed drainage from Cottonwood Creek;

(2) 48" diameter culvert to convey undisturbed drainage from the side canyon into the Cottonwood Creek culvert;

(3) Concrete inlet structures and trash racks for the above mentioned culverts;

(4) Concrete curb and gutter along the mine site to direct and convey disturbed area runoff to the sediment pond;

(5) A sediment pond, adequately sized to contain disturbed area runoff from a 10-year, 24=hour precipitation event;

(6) A series of small ditches, culverts and berms to direct and convey runoff from the disturbed area to the curb and gutter and sediment pond.

The present sediment control facilities were constructed in 1982-1983, and modified in 1990, in accordance with approved plans and regulations. Details on each of the control structures can be found in Chapter 7 of this MRP.

All buildings and structures at this mine site are constructed of substantial material, and are intended to be used for the life of the mine. Structures are constructed, operated and maintained in accordance with applicable regulations, and in a manner intended to minimize or prevent diminution of the environment and related fish and wildlife values.

# APPENDIX 5-5

# COTTONWOOD CANYON ROAD (FORMERLY APPENDIX 3-5)

# APPENDIX 3-5

# COTTONWOOD CANYON ROAD

# Emery County Road Department

P.O. Box 889
Castle Dale, Utah 84513

Phone (801) 381-5450
or
381-2550

November 27, 1989

Dan Guy
Beaver Creek Coal Company
P. O. Box 1378
Price, Utah 84501

Dear Mr. Guy,

Enclosed you will find various documents concerning the Cottonwood Road #5-06. This road has been under Emery County authority for decades. We actually end jurisdiction approximately 3 tenths of a mile above the Trail Mountain (Beaver Creek) mine. The first 2.11 miles of the roadway, from Highway 29, crosses public as well as private lands. The last one mile lies wholly within the forest boundary; over which we have maintenance authority by agreement. I have also enclosed Forest Service documentation confirming agreement over the last major road project conducted under the Mineral Lease Program beginning with Natomas' endeavors in 1982 on thru the final finish phases of 1987.

Typically, on old existing operations, we have no problem concerning mining activities located within 100 feet of our road right-of-way. On the Trail Mountain site Natomas agreed to fence, gate access and sign per our requirements. Upon project completion in 1987 all maintenance authorization returned to Emery County. Under Emery County Ordinance 8-7-85A maintenance agreements are issued assigning responsibility onto the contractor or their assigns during construction only.

If you need more information please call.

Kindest Regards,

Rex Funk,
Supervisor

RF:cjw

Enclosure

AGREEMENT

This Agreement made and entered into by and between Emery County, a body corporate and politic, hereinafter referred to as "County", and Trail Mountain Coal Company, a California corporation, hereinafter referred to as "Trail Mountain";

WHEREAS, Trail Mountain wishes to make improvements to the County road which provides access to their coal mine in Emery County, and

WHEREAS, the parties hereto wish to memorialize their agreement, and

WHEREAS, the parties hereto have each received certain benefits hereunder,

NOW IT IS, THEREFORE, AGREED AS FOLLOWS:

1. Trail Mountain has, in addition to this Agreement, complied with the Emery County Encroachment Ordinance.

2. Trail Mountain has entered into an agreement with Trail Mountain Cattlemen's Association a copy of which agreement is attached hereto and marked as Exhibit A. Said agreement is incoporated into this Agreement by reference.

3. A certain Bureau of Land Management, (hereinafter referred to as "BLM") right-of-way (U-40600) is required to complete this project. County has made application for said right-of-way which has been granted. A copy of said grant is attached hereto and marked as Exhibit B. Trail Mountain agrees to assume all obligations imposed upon County by the BLM concerning said right-of-way.

4. County agrees to obtain the necessary permits required by the United States Forest Service before any construction is undertaken upon that portion of roadway which crosses land subject to its jurisdiction. Trail Mountain agrees to assume all obligations imposed upon County by the United States Forest Service concerning said permit.

5. Trail Mountain agrees to construct said road pursuant to the plans and specifications submitted to County and dated July 22, 1983. The parties hereto agree that the construction will be completed in three phases. Phase one is construction of the road pursuant to the plans and specifications mentioned above excluding asphalt from Station 0+00 to Station 100+00. Phase two is construction of the road pursuant to the plans and specifications mentioned above excluding asphalt from Station 100+00 to Station 167+00. Phase three is asphalting the entire length of said road. Phase one is to be completed as soon as practicable. Phase two is to be completed during 1984. When Trail Mountain initiates phase three, the maintenance portion shall be renegotiated.

6. Trail Mountain agrees to maintain said road until such time as maintenance is renegotiated pursuant to paragraph 5. Should the Emery County Road Supervisor observe necessary maintenance which has not been performed he will notify Trail Mountain in writing of the needed maintenance. Should Trail Mountain fail to perform said maintenance within ten working days the Emery County Road Supervisor may cause the work to be done and submit to Trail Mountain a reasonable bill for payment. Said maintenance includes, but is not limited to, snow removal. Any maintenance of said road by County at its expense shall not alter the requirement that Trail Mountain maintain said road as indicated herein nor shall it constitute a waiver of any portion of this Agreement.

7. Bonds and liability policies will be required for each phase and will be determined according to the Emery County Encroachment Ordinance.

8. All necessary road signs, as determined by the Emery County Road Supervisor, shall be paid for by Trail Mountain. Said signs shall be placed by Trail Mountain at the direction of County.

9. Trail Mountain shall keep said road open during construction and shall be entirely responsible for the safety of the public by placing and maintaining necessary and required signs during construction.

10. All permits required by Utah Department of Transportation will be obtained by Trail Mountain. Trail Mountain agrees to comply with all applicable local, state and federal requirements.

11. The parties each agree that should they default in any of the covenants or agreements contained herein, that the defaulting party shall pay all costs and expenses, including a reasonable attorney's fee, which may arise or accru from enforcing this Agreement, or in pursuing any remedy provided hereunder or by the statutes of the State of Utah, whether such remedies are pursued by filing a suit or otherwise.

12. It is understood that the stipulations aforesaid are to apply to and bind the heirs, executors, administrators, successors, and assigns of the respective parties hereto. There shall be no modification to this Agreement except upon the express written consent of the parties hereto.

Done pursuant to motion and approval of the Board of Emery County Commissioners at a special meeting of the Board of Emery County Commissioners this 14 day of September 1983.

DATED this 14 day of September 1983.

EMERY COUNTY, a body corporate and politic

By Rue P. Ware
Chairman, Emery County Board of Commissioners

ATTEST:

Emery County Clerk

This Agreement is executed pursuant to a resolution duly adopted by the Board of Directors of Trail Mountain Coal Company authorizing the execution of said Agreement.

DATED this 14 day of September 1983.

TRAIL MOUNTAIN COAL COMPANY, a California corporation

By Joe Dilder Gen. Manager
(Title)

ATTEST:

Secretary

AGREEMENT

This Agreement entered into as of the 8th day of September 1983, by and between the Trail Mountain Cattlemen's Association, acting in behalf of the members thereof, (hereinafter referred to as "Cattlemen"), and Trail Mnt. Coal Company, a California corporation, (hereinafter referred to as "Coal Company").

Whereas, the County of Emery desires that Coal Company make certain improvements to the road between State Highway U-29 and the Trail Mountain Coal Mine, and

Whereas, the Cattlemen believe that the proposed road improvements and consequent increase in traffic speed will create a situation hazardous for the movement of cattle along the road,

Now, therefore, in consideration of the mutual covenants herein contained the parties hereby agree as follows:

1. Coal Company agrees that it will:
   (a) Repair or rebuild the corral at the mouth of Cottonwood Canyon, and
   (b) construct a new corral accessible by cattle trucks at a site to be selected by Cattlemen to the north of the Mine, and
   (c) to extend the existing drift fence north of the Mine to a point selected by Cattlemen to prevent cattle from walking around the existing fence on the west side.

All work to be completed on or before October 30, 1983 and shall conform to the specifications set forth in Exhibit A attached hereto and shall be done at Coal Company's sole cost.



EXHIBIT A

2. Cattlemen agree that they will obtain such permits, licenses and/or leases or other authorizations from the appropriate county, state or federal governments and/or from any landowners as shall be required to accomplish the work required and site the corrals referred to in paragraph 1 above. Cattlemen further agree that from and after the completion of the work specified under paragraph 1 above the Coal Company shall have no title or interest in said work and shall have no responsibility for repair or maintenance.

3. Coal Company agrees that if Cattlemen provide Coal Company's Mine Superintendent with at least 5 days prior notice of the date when it or its members desire to move cattle up or down said road then Coal Company will, for 72 hours (commencing at 7:00 a.m. of the date scheduled for cattle movement), cease all coal truck traffic on said road. Cattlemen agree to use their best efforts to minimize the number of occasions when coal truck traffic shall be so interrupted by requesting its members to coordinate their cattle drives to occur whenever reasonably possible, within the 72 hour period.

4. Cattlemen shall advise the County of this agreement and indicate that by reason thereof they support the road improvements.

5. Except as to the provisions of paragraph 1 hereof, this agreement shall continue in full force and effect for the duration of the Coal Company's mining activities in Cottonwood Canyon.

6. The parties agree that should they default in the performance of any of the provisions hereof, the defaulting party shall be responsible for all costs and expenses, including a reasonable attorney's fee, incurred by the other party in enforcing the provisions of the agreement.

7. This agreement shall be binding upon the members of Cattlemen and the heirs, executors, administrators, succussors and assigns of the parties.

IN WITNESS WHEREOF, the parties have executed this agreement as of the day and year first above set forth.

ATTEST:

"Coal Company"
TRAIL MOUNTAIN COAL COMPANY
Subsidiary of Diamond Shamrock Co.

Secretary

By

Sept 8, 1983
Debbie Hansen
Exp date - 3/31/87

ATTEST:

"Cattlemen"
TRAIL MOUNTAIN CATTLEMEN'S ASSOCIATION, for and in behalf of its members.

Secretary

By

# Emery County Road Department

P.O. Box 889
Castle Dale, Utah 84513

Phone (801) 381-5450
or
381-2550


September 28, 1987

Joe Fielder
Trail Mountain Coal Company
P. O. Box 550
Orangeville, UT 84537

RE: Construction Agreement 9/14/83

Dear Joe,

We feel that Trail Mountain Coal Mine has met and kept its part per the September 14, 1983 Construction Agreement on the Cottonwood Coal Haul Road. The construction of Phases I and II were acceptable at the commencement of Phase III (Asphalt Phase).

On September 3, 1987 the final inspection took place with the following committee:

Commissioner Jerry Mangum, Emery County
Archie Hamilton, Utah Department of Transportation
Mike Cox, Cox Rock Products
Howard Tuttle, Johansen & Tuttle Engineering
Rex Funk, Emery County Road Department

It was noted that the construction of the project appears to be a success and mutually beneficial to all concerned. Straw bales were observed on the west shoulders in the right-of-way zone just below your south fence. Allen Childs said they had been put there to satisfy DOGM temporarily and we therefore ask that you remove them or assume them as your liability hence. The signing still seems sparse at present though per the Uniform Traffic Sign Code. I feel that delineators would help mark out the west edge of the road better and will have them installed soon. The charges for signs (per agreement) will be forwarded to Trail Mountain.

Again we wish to state that we find Trail Mountain's construction participation in accord with the agreement and accept Phases I, II and III as noted above.

I have included signed project construction acceptance letters from other agencies involved in the final Phase III. We understand that DOGM is currently involved with your operation on a channel change situation. Craig Johansen says that the easement from the LDS Church set the center of the stream as the west boundary. You may want to check your files.

If this is so you should be o.k. as this puts the right-of-way for the road there. I don't have an easement copy available at this writing to verify, but feel his recollection is probably good.

Sincerely,

Rex Funk,
Supervisor

RF:cjw

genl/504

Revised 6/13/86

87 0393
mery County
Coal Haul Roads

COOPERATIVE AGREEMENT CHARGE ID CCAR02

Cottonwood Canyon Road

Engineering Service & Roadway Construction

THIS AGREEMENT, made this 19 day of JUNE, 1986, by and between the Utah Department of Transportation and Emery County, State of Utah.

WITNESSETH:

WHEREAS, it is desired by the parties to this agreement to provide for all engineering and construction of a county road known as "Cottonwood Canyon Road" which is to be financed from funds provided for by the Utah Legislature. These funds are in the U.D.O.T.'s budget and indentified for specific use by counties. This project is located in Emery County and junctions with S.R. 29.

WHEREAS, Emery County will use the funds identified in U.D.O.T.'s budget to pay all or nearly all of the costs of the roadway construction and the construction engineering, and it is Emery County's desire to advertise the project for bidding proposals, award the contract, manage all monies and payments thereof, and provide construction engineering and project supervision.

Now, there. :e, the UTAH DEPARTMENT O.

TRANSPORTATION and EMERY COUNTY do hereby agree as follows:

1. Defination of Terms: For the purpose of this agreement, the following terms shall be construed respectfully to mean:

   a. U.D.O.T. - The Utah Department of Transportation or its representatives.

   b. Local Agency - Emery County, State of Utah, acting through its Board of Commissioners.

   c. Project - The "Cottonwood Canyon Road" designated for subgrade widening and surface rehabilitation.

   d. Maintenance of Properly Maintain - The making of needed repairs and the preservation of a reasonably smooth surface.

   e. Construction Manager (Project Engineer) - The representative assigned by the local agency to engineer and manage the project.

   f. Preliminary Engineering - Work necessary to complete Plans, Specifications, Estimate, and Contract.

   g. Construction Engineering - Work in connection with engineeing and management of contract, plans and specifications, during construction.

budget for use by Emery County to rehab coal haul roads.

2. Description of Work Involved:

The work covered by this agreement and the financing of which is provided herein, shall consist of the following:

a. All engineering necessary to prepare Plans, Estimate, and contract for construction of "Cottonwood Canyon Road".
b. Reconstruction of subgrade and bituminous paving of the "Cottonwood Canyon Road".
c. All engineering necessary for the management of all construction activities needed to complete this project.

3. Preconstruction Engineering:

The local agency will develope plans and specifications in accordance with the minimum roads standards as approved by U.D.O.T. Certifications as to clearances of all utilities, right-of-way and easements will be furnished to U.D.O.T. by the Emery County Board of Commission. Emery County will advertise the

project, furnish completed plans and specifications for bidder proposals and award a contract under State of Utah, Standard Specifications for Road and Bridge Construction, Edition of 1979 and Addendums.

4. Construction and Construction Engineering

The project shall be constructed by contract under State of Utah, Standard Specifications for Road and Bridge Construction, Edition of 1979 and Addendums. The local agency shall provide a project construction manager (project engineer), lab technicians, field crew to supervise the project. U.D.O.T. will attend the preconstruction conference and the "Final Estimate" field inspection of the project.

5. Financing of Project:

Funds for this project were provided for by the Utah Legislator from mineral lease monies and placed in U.D.O.T.'s budget. These funds are identified for specific use by "Counties". The total available funds for this project for road construction and engineering services is $1,100,000.00. These monies shall be considered a block grant with no other funds being made available by U.D.O.T.

U.D.O.T. will receive full payment for any service, construction engineering or administration, performed relative to this project. The local agency shall hold U.D.O.T. free and harmless from any and all liabilities, damages and claims that may result from the administration, engineering, and construction of this project. Preconstruction engineering is not eligible for funding credit. Emery County will process all contract vouchers for payment. After a project final estimate is approved and all contract vouchers processed for final payment, any funding balance can be transferred to any other high priority coal haul road in Emery County. Any transfer request will be reviewed and approved by U.D.O.T.

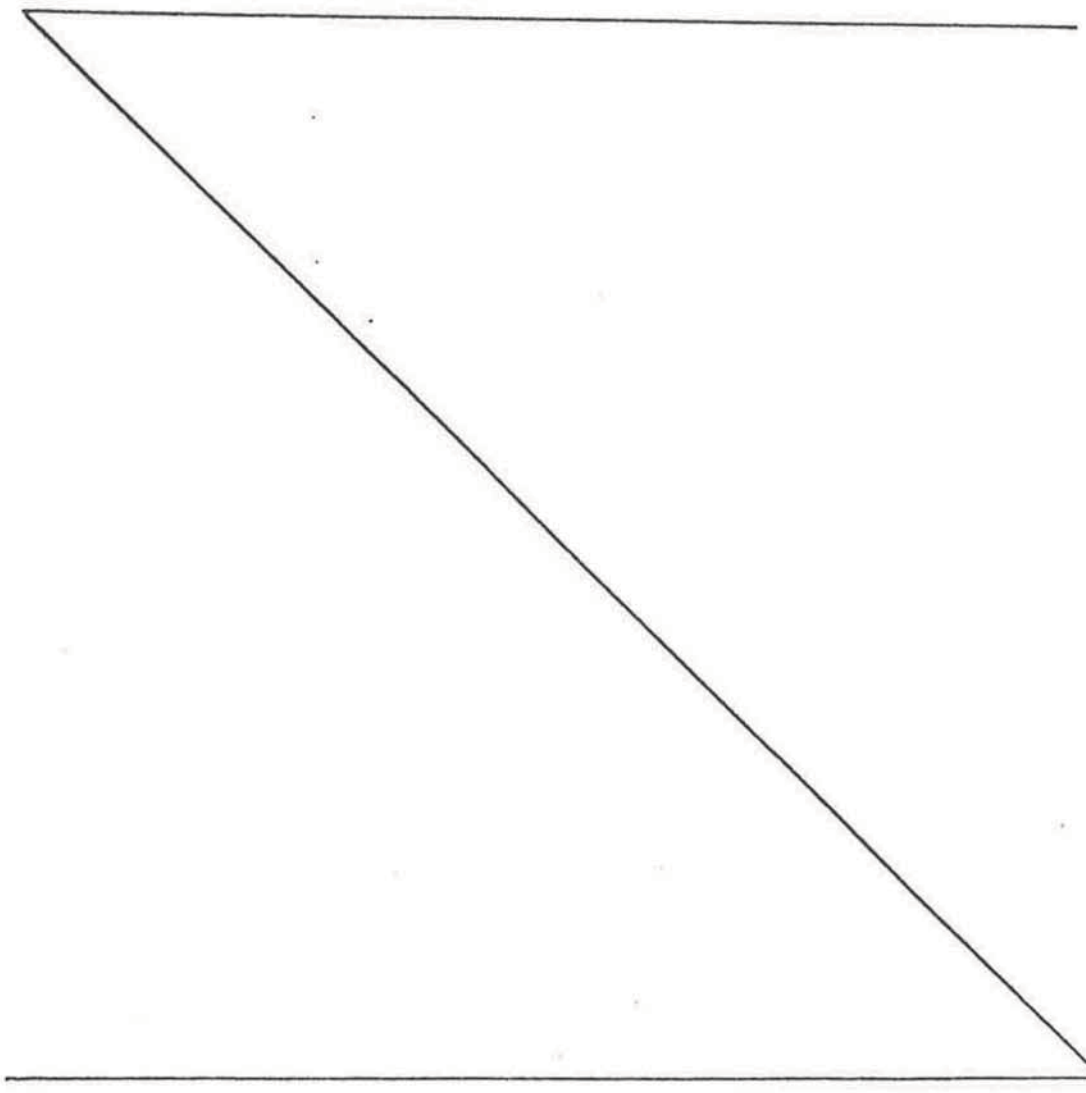
6. Maintenance

The project, after completion, shall be properly maintained throughout by the local agency in a manner satisfactory to the U.D.O.T. and the Federal Highway Administration.

7. Release of Funds

These funds indentified in U.D.O.T.'s budget

will be released to the local agency after the project contractor has been paid by Emery County. Emery County will prepare partial payment invoice's and along with contractor partial estiamte vouchers, they will submit same to U.D.O.T. for release of funds. Upon receipt of the documents, U.D.O.T. will immediately release the amount of funds requested. The total amount of funds requests will not exceed $1,100,000.00.



IN WITNESS WHEREOF, the parties have hereto caused these present to be executed by their duly authorized offices as of the day, month and year first above written.

EMERY COUNTY, STATE OF UTAH

ATTEST:

By: _____

Title: Emery County Clerk

Title: Emery County Commission Chairman

UTAH DEPARTMENT OF TRANSPORTATION

ATTEST:

By: _____

Title DIRECTOR

Title

**********

RECOMMENDED FOR APPROVAL:

District Director

FUNDS AVAILABLE:

for Budget Director

FUNDS APPROVED:

Local Government Proj. Engr.

Director of Finance

APPROVED AS TO FORM:

Engr. for Plan./Program.

Assistant Attorney General

APPROVED:

for Comptroller

Cooperative Agreement
Emery County Coal Haul Roads
Preliminary Engineering Services

U-5078

This agreement, made this 29th day of November, 1985, by and between the Utah Department of Transportation and Emery County, State of Utah.

WITNESSETH:

Whereas, it is desired by the parties to this agreement to provide for the preconstruction engineering of Emery County Coal Haul Roads known as "Consolidation Mine Road" and "Cottonwood Canyon Road", which engineering is being financed from funds provided by the Utah Legislature. These funds are in U.D.O.T.'S budget and identified for specific use by "Counties". These projects are locatd in Emery County and junction with S.R. 29 and US-10.

Whereas, Emery County will use the funds identified in U.D.O.T.'S budget to offset the cost of preparing plans and specifications, for these projects (ready to advertise for contract), depending upon the availability of construction funds from U.D.O.T.

Now, therefore, The Utah Department of Transportation and Emery County do hereby agree as follows:

1. Defination of Terms: For the purpose of this agreement, the following terms shall be construed respectfully to mean:

   a. U.D.O.T. - The Utah Department of Transportation or its representatives.
   b. Local Agency - Emery County, State of Utah, acting through its Board of Commissioners.
   c. Project - The Consolidation Mine Road and the Cottonwood Canyon Road designated for subgrade widening and surface rehabilitation.
   d. Project Manager - The Emery County surveyor or his designate.
   e. Preconstruction Engineering - Work necessary to complete plans, specifications, and contract documents ready for bidding.
   f. Funds - Monies identified in U.D.O.T.'S budget for use by counties to rehab coal haul roads.

2. Description of Work Involved: The work covered by this agreement shall consist of preconstruction engineering, which is the preparation of complete plans, specifications, and contract package for Coal Haul Roads known as Consolidation Mine Road and Cottonwood Canyon Road.

3. Preconstruction Engineering: Plans and specifications will be developed by the project manager for the local agency in accordance with minimum road standards and as approved by U.D.O.T. Certifications as to clearance of all utilities, rights of ways and easements will be furnished to U.D.O.T. by the local agency. Plans and specifications will be advertised and contracts awarded under the State of Utah Standard Specifications for Road and Bridge Construction, Edition 1979.

4. Financing of Project: Funds for this project are provided by the Utah Legislature and plaed in U.D.O.T.'S budget, being indentified for specific use by "Counties". The estimated total cost of the work as described above is $45,000. The cost is broken down as $37,000 for the Consolidation Mine Road and $8,000 for the Cottonwood Canyon Road. U.D.O.T. will receive payment for any services, engineering or administrative function, performed relative to this project from the existing local agency's account of $5,000 which is identified in U.D.O.T.'S budget.

Emery County will receive these funds from U.D.O.T by submitting a full itemized bill of work performed on a monthly basis to U.D.O.T. District #4 Headquarters, Route 3, Box 75C5, Price, Utah 84501. All files and accounting will be subject to audit by U.D.O.T.

IN WITNESS WHEREOF, the parties have subscribed their names through their proper officers duly authorized as of the day and year first above written.

EMERY COUNTY, STATE OF UTAH

ATTEST

Title: Emery County Clerk

By Clyde E Commissio

Title: Chairman, Emery County Commissio

UTAH DEPARTMENT OF TRANSPORTATION

ATTEST

Title: Commission Secretary

By:

Title: DIRECTOR

**********

RECOMMENDED FOR APPROVAL:

District Director

FUNDS AVAILABLE:

N/A

Budget Director

FUNDS APPROVED:

Local Goverment Projects Engineer

N/A

Director of Finance

APPROVED AS TO FORM:

Engineer for Planning Programming

Assistant Attorney General

APPROVED:

REVIEWED COMPTROLLER

Comptroller

# United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Moab District
San Rafael Resource Area
P.O. Drawer AB
Price, Utah 84501

IN REPLY
REFER TO:

2810
U-40600
(U-067)

RIGHT-OF-WAY

U-40600

Section A

1. There is hereby granted, pursuant to Title V of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1761), a nonexclusive, nonpossessory right-of-way to:

Emery County
Emery County Courthouse
Castle Dale, Utah 84513

In case of change of address the holder shall immediately notify the Authorized Officer.

2. To use, subject to terms and conditions set out below, the following described Public Land.

Salt Lake Meridian
T. 17 S., R. 7 E.,
Sec. 31, Lots 2-4, SE¼SW¼SE¼
T. 18 S., R. 7 E.,
Sec. 6, Lot 3, E½

3. Description of the right-of-way facility and purpose:

The right-of-way is a road to be improved, maintained and used as part of the Emery County road system. The right-of-way width is 100 feet and 1.8 miles in length and contains 21.8 acres, more or less.

A map showing the location of the right-of-way over the above described public land is attached hereto as Exhibit "A".

TERMS AND CONDITIONS

Section B

1. The right-of-way holder agrees to comply with all the applicable regulations contained in 43 CFR 2800.

2. If the right-of-way holder violates any of the terms and conditions to this grant, the Authorized Officer, after giving written notice may declare the grant terminated.

3. This grant is subject to all valid rights existing on the effective date of this grant.

4. There is hereby reserved to the Authorized Officer the right to grant additional rights-of-way or permits for compatible uses, on, over, under, or adjacent to the lands involved in this grant.

5. The Holder shall comply with the applicable Federal and State laws and regulations concerning the uses of pesticides (i.e., insecticides, herbicides, fungicides, rodenticides, and other similar substances) in all activities/operations under this grant. The Holder shall obtain from the Authorized Officer approval of a written plan prior to the use of such substances. The plan must provide the type and quantity of material to be used; the pest insect, fungus, etc., to be controlled; the method of application; the location for storage and disposal of containers; and other information that the Authorized Officer may require. The plan should be submitted no later than December 1 of any calendar year that covers the proposed activities for the next fiscal year (i.e., December 1, 1983, deadline for a fiscal year 1985 action). Emergency use of pesticides may occur. The use of substances on or near the right-of-way shall not be used if the Secretary of the Interior has prohibited its use. A pesticide shall be used only in accordance with its registered uses and within other limitations if the Secretary has imposed limitations. Pesticides shall not be permanently stored on public lands authorized for use under this grant.

6. The Holder agrees not to exclude any person from participating in employment or procurement activity connected with this grant on the grounds of race, creed, color, national origin, and sex, and to ensure against such exclusions, the Holder further agrees to develop and submit to the proper reviewing official specific goals and timetables with respect to minority and female participation in employment and procurement activity connected with this grant. The Holder will take affirmative action to utilize business enterprises owned and controlled by minorities or women in its procurement practices connected with this grant. Affirmative action will be taken by the Holder to assure all minorities or women applicants full consideration of all employment opportunities connected with this grant. The Holder also agrees to post in conspicuous places on its premises which are available to contractors, subcontractors, employees, and other interested individuals, notices which set forth equal opportunity terms; and to notify interested individuals, such as bidders, contractors, purchasers, and labor unions or representatives of workers with whom it has collective bargaining agreements, of the Company's equal opportunity obligations.

7. The right-of-way herein granted is subject to the express covenant that it will be modified, adapted, or discontinued if found by the Secretary to be necessary, without liability of expense to the United States, so as not to conflict with the use and occupancy of the land for any authorized works which may be hereafter constructed thereon under the authority of the United States.

8. The Holder shall indemnify the United States against any liability for damage to life and property arising from the occupancy or use of public lands under this grant.

9. All survey monuments, witness corners, reference monuments and bearing trees must be protected against destruction. Any damaged or obliterated markers must be re-established in accordance with accepted survey practices at the expense of the Holder.

10. The right-of-way shall be relinquished to the United States if the authorized use is no longer needed.

11. Compliance shall be in accordance with the terms and conditions as specified herein and in Exhibit "B", attached hereto and made a part hereof.

12. The Holder is exempt from paying a rental fee in accordance with 43 CFR 2803.1-2(c)(1).

13. This right-of-way grant shall terminate 30 years from the effective date of this grant unless prior thereto it is relinquished, abandoned, terminated, or otherwise modified pursuant to the terms and conditions of this grant or of any applicable Federal law or regulation.

a. This grant is subject to review at the end of 20 years from the date of this decision, and at regular intervals thereafter not to exceed 10 years.

b. This grant may be renewed so long as it is still being used for the purposes granted, and is operated and maintained in accordance with all the provisions of this grant and pursuant to the regulations under which it is granted. If renewed the right-of-way will be subject to regulations existing at the time of renewal, and such other terms and conditions deemed necessary to protect the public interest.

Section C

The effective date of this right-of-way grant is the date of execution by the Authorized Officer.

The undersigned agrees to the terms and conditions of the right-of-way grant.

The right-of-way is executed this _____ day of _____, 198__

_____
Name of Organization, Company or Corp.

By: _____

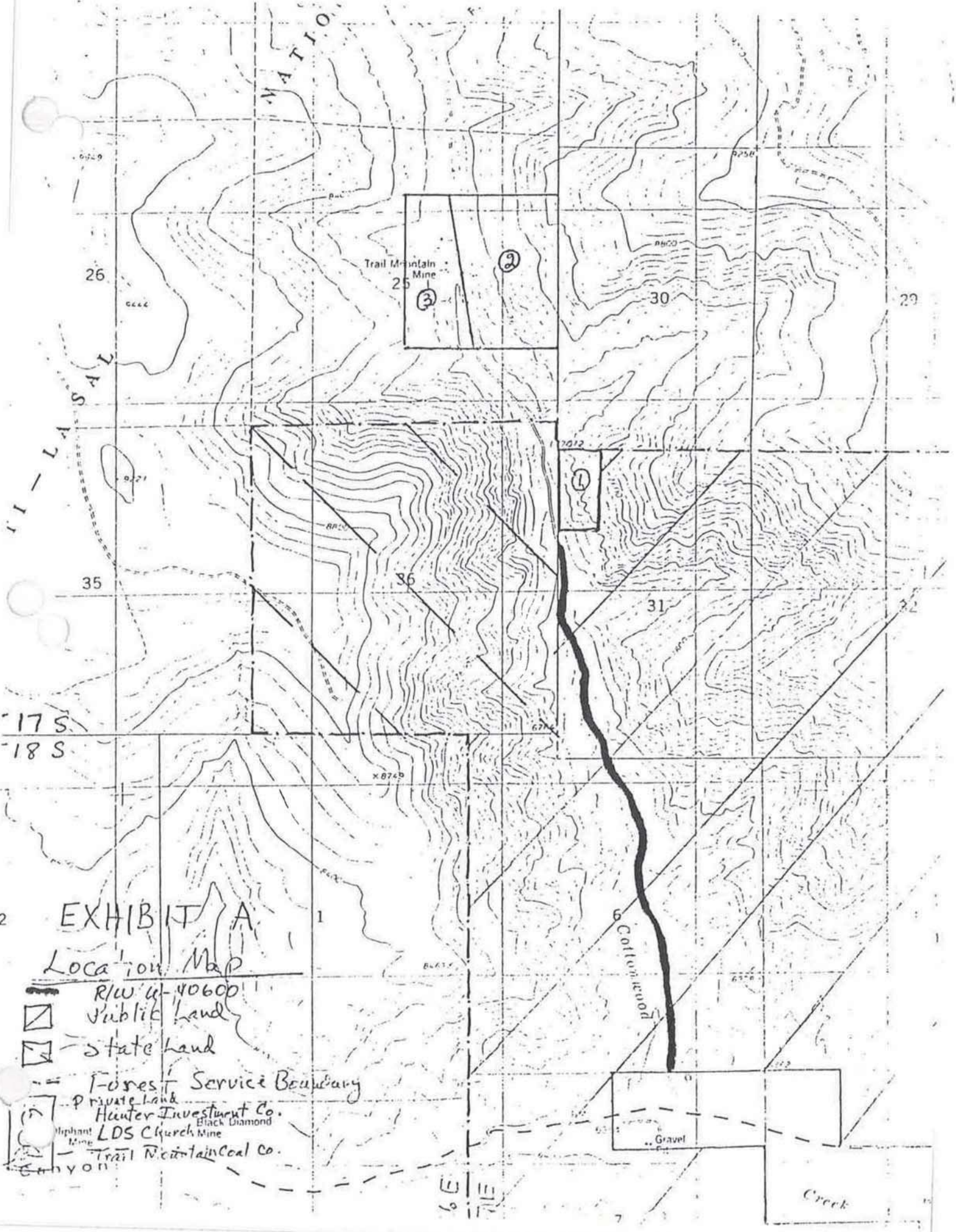
Title: _____

Date: _____

Termination Date:

_____

_____
Area Manager


Trail Mountain Mine
26
25
30
29
35
36
31
32
17 S
18 S
1
6
Gravel
Creek
Canyon
EXHIBIT A
Location Map
R/W U-40600
Public Land
State Land
Forest Service Boundary
Private Land
Hunter Investment Co.
Black Diamond
LDS Church
Mine
Trail Mountain Coal Co.

2810
U-40600
(U-067)

EXHIBIT "B"

Terms and Conditions

1. If the Holder or its contractors require materials from public lands, application shall be made under applicable regulations for such materials.

2. The Holder shall comply with applicable federal, state and local laws and regulations affecting in any manner construction, operation, maintenance or termination of the right-of-way grant.

3. The Holder shall protect existing telephone, telegraph and transmission lines, roads, trails, fences, ditches, and like improvements during construction, operation, maintenance and termination of the project. Damage caused by Holder to these systems shall be promptly repaired by the Holder to a condition satisfactory to the Authorized Officer. The Holder shall assure reasonable access for the Forest grazing allotment users.

4. The Holder shall notify the San Rafael Resource Area at least 48 hours before beginning any construction (phone 637-4584).

5. All construction activities shall be confined to the minimum area necessary and shall not exceed the 100 foot right-of-way width granted herein. The exterior boundaries of the right-of-way shall be clearly flagged prior to any surface disturbing activities.

Holder shall place slope stakes, culvert location, and grade stakes, and any other construction control stakes necessary to insure construction of this road, in accordance with all the technical information submitted with this right-of-way. If stakes are disturbed for any reason prior to or during clearing or topsoil removal, they shall be replaced before proceeding with the construction of the road.

6. Clearing will be held to a minimum and permitted only within the right-of-way, except that hazard trees outside the right-of-way may be cut with the approval of the Authorized Officer.

Vegetative debris and slash which is cut or cleared shall be completely disposed of by complete disposal or cut into 4 foot lengths for firewood. Stumps of cut trees shall be less than 12 inches in height.

7. The Holder shall make every reasonable effort to avoid or minimize dust problems. The Authorized Representative may require sprinkling, or other means of dust control on the road.

Any dust control measures required shall be continued for as long as necessary to effect control during the life of the project. These measures shall include, where necessary, sprinkling with water or similar actions at construction sites and project facilities.

8. The Holder shall comply with all state and federal regulations and laws pertaining to water quality, public health and public safety.

The Holder shall provide for the protection and enhancement of aesthetic values in the planning, construction and maintenance of the road.

Blasting is prohibited within 500 feet of any springs, unless otherwise permitted by the Authorized Officer.

Topsoils that have been excavated during construction shall be stockpiled and evenly spread over the disturbed area and seeded as determined by the Authorized Officer.

Trees, shrubs, grass and natural features that are not removed will be protected to the fullest extent possible from damage during construction.

9. Public Access. During construction, the Holder shall regulate access and vehicular traffic as required to facilitate construction operations and to protect the public, wildlife and livestock from hazards associated with the project. For this purpose, the Holder shall provide warnings, flagmen, barricades and other safety measures as circumstances require.

The Holder shall permit free and unrestricted public access to and upon the right-of-way for all lawful and proper purposes, except in areas designated as restricted by the Holder with the consent of the Authorized Officer in order to insure public safety and facilities constructed on the right-of-way.

The Holder acknowledges and agrees that the grant of this right-of-way is subject to the express condition that the exercise thereof will not unduly interfere with the management, administration or disposal of the United States of the lands affected thereby, or the full and safe utilization by the United States, for necessary operations incident to such management, administration or disposal.

10. The Holder shall immediately bring to the attention of the Authorized Officer any cultural or paleontological resources discovered during operations under this grant. The Holder shall not disturb any cultural or paleontological resources except as instructed by the Authorized Officer. The cost of investigating and protecting cultural resources discovered during operations shall be borne by the Holder.

11. The construction area will be kept clean at all times. All trash, packing material, oil residues, and other refuse or waste materials will be removed from construction areas on public land and placed in approved sanitary landfills.

12. During construction there will be periodic inspections by the Authorized Officer or his designee to ensure compliance.

13. Site Restoration. All public land areas where soils and surface materials are disturbed through construction or other actions incident to project operations shall be restored to their natural state insofar as practicable by water barring, scarifying, leveling, reseeding or other practices as prescribed by the Authorized Officer and to his satisfaction.

Excess excavated materials shall be loaded, overhauled, and disposal of at disposal sites shown on the plans. The materials placed shall be sloped and shaped to blend with the surrounding terrain and otherwise brought into a condition acceptable to the Authorized Officer. These materials shall not be disposed of on areas where the material will encroach on a stream course or other body of water or be subject to eroding into the stream.

All disturbed areas shall be reseeded to a mixture of grasses, browse and forbs as prescribed by the Authorized Officer, including location, season, rates, seed mixtures and methods of planting.

Whenever revegetation is required, the Holder shall file a report with the Authorized Officer when such planting is completed. The report shall contain information regarding the location of the area; the type of planting or seeding, including mixtures and amounts; the date of planting; and other relevant information as may be required by the Authorized Officer.

Inspection and evaluation of restorative measures taken will be made by the Authorized Officer as soon as it is possible to determine if a satisfactory growth has been established. In no instance shall this vegetative cover check be made until after completion of the first growing season.

14. Seeding shall take place from October 1 to November 30. Seeding method shall be by drilling and/or harrowing and will be repeated until vegetation is successfully established unless otherwise approved in writing by the Authorized Officer. The following seed mixture shall be used except in areas covered by Paragraph 15:

| Type | Rate (lbs./acre) |
|---|---|
| Intermediate wheatgrass | 2 |
| Crested wheatgrass | 2 |
| Western wheatgrass | 2 |
| Indian ricegrass | 2 |
| Fourwing saltbush | 1 |
| Ephedra (Morman tea) | 1 |
| Yellow sweet clover | 2 |
| Total | 12 |

15. To protect the riparian zone and stream channels, the Holder shall:

(a) Stabilize the road toe by using large rocks (greater than 12 inches diameter) for armor or riprap and reseeding with a mixture of grasses and forbs as specified by the Authorized Officer following construction.

(b) Plant cottonwood and willows (3-6 feet high) along the road toe where it contacts the riparian zone. Cottonwood trees and willows should also be planted in areas where channel realignment causes the stream to be diverted away from the existing riparian zone.

Turbidity in Cottonwood Creek below the confluence of Straight Canyon shall not be increased by more than 10 percent over the turbidity in Straight Canyon above the confluence for more than five consecutive days as a result of

the road or operation of the road. If the turbidity increase exceeds 10 percent for more than five days, the Holder must take appropriate measures to reduce the level.

In the construction of channel changes and stream-crossing embankment sections, natural stream flow shall be maintained at all times, unless otherwise provided.

16. Compliance. When all development and rehabilitation have been completed a joint compliance check of this right-of-way will be made by the Holder and the Authorized Officer to determine compliance with the terms and conditions of this grant. The Holder shall perform at his own expense any required modifications or additional reclamation work needed to comply with the terms of this grant.

17. If at any time hereafter the Holder wishes to reconstruct, remodel or relocate any portion of this right-of-way hereby granted, or any of the improvements thereon, the prior written approval of the Authorized Officer must be obtained. No such approval will be given unless the request is fully justified by the Holder and is authorized by law. Where necessary, the Holder shall make application under appropriate regulations.

18. No assignment shall be recognized unless or until it is approved in writing by the Authorized Officer in accordance with 43 CFR 2803.6-3 and 2803.6-4.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Manti-LaSal National Forest
599 West Price River Drive
Price, Utah 84501

7700

May 12, 1983

Mr. Bevan Wilson
Emery County Commissioner
P.O. Box 889
Castle Dale, Utah 84513

Dear Mr. Wilson:

We have reviewed the preliminary plans submitted by Natomas Coal Company for design of the Cottonwood Road leading to the Trail Mountain Mine.

We recommend the following revisions:

1. Change the alignment at the beginning of the project, so that the road intersects State Route 29 at an angle of $90^{o} \pm 15^{o}$.

2. Specify the superelevation rate for each curve. Some curves will need to have greater than minimum superelevation and/or a flatter curve in order to achieve a design speed of 35-40 mph on graveled surfaces in inclement weather (using a side friction factor of 0.10). Be sure to account for superelevation transitional distances in and out of curves.

3. Include the hydrologic design calculations for each natural drainage culvert for review. We recommend less distance between certain culverts and have indicated so in the drawings.

4. Correction to the erroneous curve data.

5. Reduce the crown to 2% from centerline to the shoulder, with a 4' minimum shoulder width at a minimum slope of 4:1, and show this on the typical cross-section.

6. Show pavement compositions (temporary and finished grade) and depths on the typical cross-section.

7. Show ditch depth on typical cross-section (1' minimum).

8. Provide cross-section at 100 foot intervals.

Please return our copy of the road plan after you have reviewed the identified deficiency.

If you have any questions, please contact Brent Barney or Craig Falkum at our Supervisor's Office in Price, Utah.

Sincerely,

W. W. Bailey

for
REED C. CHRISTENSEN
Forest Supervisor

Enclosure

# Emery County Road Department

P.O. Box 889
Castle Dale, Utah 84513

Phone (801) 381-5450
or
381-2550


July 15, 1987

John Neibergall
U. S. Forest Service
98 South State Street
Ferron, UT 84523

RE: Cottonwood Canyon Project
Emery County

Dear John,

Emery County is in the process of accepting the project on the Cottonwood Canyon Road and request a release from your agency stating that all concerns that your agency had, have been met and the project, as constructed is acceptable.

Please return this letter with the appropriate signature (note the signature line at bottom of page).

If you have any questions or comments please address them to our department as soon as possible.

Sincerely,

Rex Funk/cjw

Rex Funk,
Supervisor

RF/cjw

The Cottonwood Canyon Project is acceptable as far as the U. S. Forest Service is concerned.

John Neibergall

Representative

U. S. Forest Service

7-28-87

Date

prj/347

# APPENDIX 5-6

# TECHNICAL DATA INFORMATION

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 3-6

# TECHNICAL DATA INFORMATION

Beaver Creek Coal Company
Trail Mountain No.9 Mine

Technical Data Information

The following information is submitted to satisfy the requirements of UMC771.23(c), for technical data in the M.R.P. The list is broken down by Chapter, in which the technical data is found, followed by the person or organization which supplied the data (1), the dates of collection (2) and the methodologies or analysis methods (3).

Operations

(1) Delta Technical Consultants, Inc.
137 W. 2260 So.
Salt Lake City, Utah 84115

(2) Dates of Collection: 7/85

(3) Slope Stability Analysis for Tipple Area at Trail Mountain.

Cultural and Paleontological Resources

(1) Archeological - Environmental Research Corp.
Salt Lake City, Utah

(2) Dates of Collection: 7/79 & 7/83

(3) Cultural and Historical Survey for Trail Mountain Permit Area and Exploratory Drilling Locations

(1) Division of State History
Salt Lake City, Utah

(2) Dates of Collection - 4/86

(3) Determination of no cultural or historic site or project area.

Geology

(1) U.S. Department of Interior
Minerals Management Service
Salt Lake City, Utah

(2) Dates of Collection: 3/82

(3) Resource Recovery Report - Trail Mountain Tract.

(1) Utah Geological and Mineral Survey

(2) Dates of Collection - 1975

(3) Coal Drilling at Trail Mountain
North Horn Mountain and John's Peak Areas,
Watach Plateau, Utah.

Vegetation and Soils Monitoring

(1) Patrick D. Collins, Ph.D.
Mt. Nebo Scientific
P.O. Box 337
Springville, Utah 84663

(2) Dates of Collection: 1985 thur 1988

(3) Quantitative and Qualitative Sampling of Test Plots

Wildlife

(1) L.B. Dalton, et.al.
Utah Division of Wildlife Resources

(2) Dates of Collection: 1978 & 1981

(3) Species list of vertebrate wildlife that inhabit southeastern Utah (1978)
Wildlife Resource Study of Trail Mountain (1981)

(1) U.S. Fish and Wildlife Service

(2) Dates of Collection - 1981

(3) Helicopter Raptor Survey

(1) Dennis K. Shiozawa and Calvin C. Speas
Department of Zoology
Brigham Young University
Provo, Utah 84602

(2) Dates of Collection : 7/31/85 & 10/25/85

(3) Report on Benthic Macroinvertebrates of Cottonwood Creek.

Climatology and Air Quality

(1) Utah Power and Light Company

(2) Dates of Collection - 1983 thur 1984

(3) Meteorological Measurements in Huntington Canyon

Beaver Creek Coal Company
Trail Mountain No.9 Mine

(1) Utah State University

(2) Dates of Collection - 1917 thur 1960

(3) Hydrologic Atlas of Utah - Meteorologic Data for Hiawatha and Castle Dale stations

Geotechnical

(1) Bruce T.S. Ware
Registered Land Surveyor

(2) Dates of Collection - 1986 - 1988

(3) Subsidence Monitoring - Conventional Survey

(1) Mr. Leonard Witkowski
Englewood, Colorado 80112

(2) Dates of Collection : 11/85

(3) Coal Pillar Strength Calculations.

APPENDIX 5-7

NEW VENTILATION PORTAL

# APPENDIX 3-7

# PROPOSED NEW VENTILATION PORTAL

9/24/90

## Appendix 3-7

**Trail Mountain No. 9 Mine**
**New Ventilation Portal**

### General

This project consists of the installation of a new ventilation portal approximately 1000' south of the existing fan portal. The primary purpose of the portal will be to provide intake air to the mine; however, as ventilation requirements change, it may become necessary to place a fan at this location in the future.

The proposed portal is located at the southern end of an old existing access road along the outcrop. This road was put in to provide access to the original portals and mine workings (probably in the 1940's or earlier). A portion of this road is not within the existing No. 9 Mine disturbed area; therefore, an incidental change in the disturbed area perimeter is required.

Since the access was previously disturbed, this action will require very little, if any, new disturbance.

The portal will be driven to the surface from inside, and is located at a point adjacent to an old, sealed portal. A highwall and pad already exist at this location. The surface work will consist of regrading the existing road and pad, and installing a berm along the outer edge for drainage control. The access road will be used only occasionally and therefore, will be classed as an ancillary road.

9/24/90

Disturbed

This project will require the addition of approximately 0.340 acres to the No. 9 Mine disturbed area. This, coupled with the proposed culvert extension of 0.471 acres, will expand the existing disturbance of 8.80 acres by 0.811 acres, or a total of 9.22%. Additional disturbance will be limited to the existing road and pad.

Installation Procedure

The new portal will be driven to the outside from within the mines as shown on Figure 3-6A. The portal entry will be supported by steel cross-beams placed on 4' centers for at least the last 100' to the surface, and will extend at least 8' beyond the opening (see"Portal Detail" drawing).

The access road will be cleaned up and bladed. Loose, hanging material from the highwall may be removed if it presents a hazard. A berm no less than 30" high will be installed along the outer edge of the road for drainage control. Because of the slope of the existing road, a portion of the road drainage will be directed into the pond via the existing switchback diversion ditch. The remaining portion of the road will drain towards the portal and

underground. Calculations and expected flows are provided in this appendix. Once the work is complete, the berm and outslopes of the reconstruction will be seeded using the approved seed mix for contemporaneous reclamation.

Environmental Considerations

1- Disturbed Area - This project will "disturb" an area of approximately 0.340 acres. The area was previously disturbed and never reclaimed; however, it has not been included in the No. 9 Mine disturbed area until now.

2- Drainage Controls

a. Description - Drainage control will be provided by a 30" berm along the outer edge of the road and pad. The road and pad areas will be sloped to drain to the pond and underground. Runoff to the pond will be via the existing switchback diversion, which is adequately sized to carry the additional flow.

b. Additional Drainage - The additional drainage area is shown on Figure 7-11. The portions which drains to the pond is approximately 3.79 acres of undisturbed area and 0.18 acres of disturbed area. Runoff from these areas is calculated based on the

10 year-24 hour event for the area. Total runoff volume is calculated to be 0.25 ac. ft. and flow is estimated to be 4.65 cfs. The portion that drains to the mine is approximately 3.67 acres of undisturbed area and 0.16 acres of disturbed area. Total runoff volume from the 10 year-24 hour event is calculated to be 0.24 ac. ft. Since this is an insignificant amount of water, it will not need to be pumped, or otherwise removed from the mine; therefore, the runoff does not need to meet applicable water quality standards or effluent limits. Also, since this is a small amount of water (less than 80,000 gallons over a 24 hour period), and peak flows are calculated to be less than 5 cfs, there is no possibility of inundation or flooding as described by M.S.H.A. in the 30 CFR regulations, 30 CFR 75.1716 and 75.1716-1; therefore, no M.S.H.A. approval is required for this small surface drainage entering the mine. Details of these calculations are shown in the enclosed tables, and summarized in Chapter 7 of the M.R.P.

c. Map - Drainage controls are shown on the enclosed map Figure A-3-7-1 and on Figure 7-11 of the M.R.P.

d. Controls - As previously mentioned, a berm will be installed to provide drainage control, and as a required M.S.H.A. safety control. The berm will be constructed to the specifications shown on the "Road Section Typical" included in this Appendix.

The sediment pond inlet ditch from the switchback area is described in Chapter 7 of the M.R.P. ; however, calculations are included with this Appendix for clarification.

e. Calculations - Calculations for all hydrologic control structures for this project are also summarized in this Appendix.

3. Topsoil - The area involved in this project was previously disturbed, and no topsoil was saved. Since this is primarily a regrading or redisturbance of that area, no topsoil exists; therefore, there are no plans to salvage topsoil at this site.

4. Vegetation - A minor amount of vegetation has come back onto the previously disturbed area. Once construction of the project area is completed, BCCC will reseed the berm and downslope area using the approved seed mix and methodology for contemporaneous reclamation. This should provide an enhancement to the existing vegetative resource in this area.

5. Wildlife - Impacts to wildlife as a result of this project should be extremely minor or non-existent. As with any disturbance, the potential exists for increased sediment loading to streams from runoff; however, the installation and maintenance of drainage and sediment controls will minimize this possibility. No other wildlife impacts are anticipated; therefore, no mitigation procedures are proposed for this project.

6. Dust Control - If dust should become a problem during construction, the area will be watered as necessary. The road is to be used only on an occasional basis, and is to be classed as an ancillary road. As a result, dust from traffic or other use of the area is not expected to be a problem.

7. Cultural/Historical/Archaeological Sites - Although this is an old mining area, there are no sites at this location listed by the Historical Society for preservation. Studies in the area (Chapter 5 of the M.R.P.) also show no archaeological or other notable cultural resources in the project area.

Operations Plan

The portal will be used to provide intake air to the underground mining operations. The access road will be maintained as necessary to provide occasional access into the mine for inspectors and an escapeway. Berms and ditches will also be maintained as safety controls, and to provide drainage control as designed.

The portal will be maintained in a safe and stable condition. There are no plans to fence or otherwise close the portal during the operation; however, warning signs will be posted as required

by law.

As mentioned previously, this portal may eventually be used for a new fan installation. Under this scenario additional pad area would be required; therefore, additional plans would need to be submitted and approved prior to installation.

Reclamation Plan

The portal will remain until no longer needed by the operation. Upon completion of operations, structures will be removed and the portal will be sealed and backfilled according to the approved plan in the M.R.P.. Once the portal is sealed and backfilled, the road and pad area will be reclaimed to the configuration shown on Figures 3-12 and 3-12A. A typical cross-section of the reclaimed area is also shown on the "Road Section Typical" in this Appendix.

Since the area was previously disturbed and no topsoil was saved, it is proposed to use the disturbed area fill for a planting medium as planned for the rest of the minesite. Also, since the cut material was cast down the slope, it will not be possible to recover enough material to completely eliminate the highwall.

Backfilling will take place by reaching over the bank with a backhoe and placing the recovered material against the highwall. Equipment and procedure will be as per the reclamation plan

in the M.R.P..

Once backfilling is complete, the area will be revegetated in accordance with the approved seed mix and permanent reclamation procedures.

Since the existing downcast material is proposed to be used as substitute topsoil during final reclamation of this area, soils sample have been taken of this material and are presently being analyzed for the parameters listed in Table 6 of the Division Guidelines. Results of the analyses will be forwarded to the Division upon receipt.

In addition to the soil analyses, Beaver Creek Coal Co. will reseed the downcast area and berm in accordance with the plan for Contemporaneous Reclamation. Ongoing evaluation of the vegetation success will further substantiate the adequacy of these soils for final reclamation.

## Other Agency Approvals Required

This project will require additional approvals from the Bureau of Land Management (lessor of coal) and from the Mine Safety and Health Administration.

Variances to Existing Plans

Outcrop protection is provided by leaving a minimum barrier of 200' between mine workings and the coal outcrop. One exception to the above is the eastern-most entry of the 3-entry system driven north and northeast to the new ventilation portal. The eastern entry is located within the 200' barrier for a distance of approximately 240', and at no time comes closer than 160' from the outcrop. The 3-entries were necessary to meet M.S.H.A. regulations and provide adequate ventilation. The location of this variance is in the side canyon approximately 1700' south of the fan portal, and is shown on Figures A-3-7-2.

Construction Schedule

This project is projected to start between Oct. 15 and Nov. 1, 1990 and be completed within approximately 3 weeks after that date.

Bond Revision

Calculations for the increase in the Reclamation Bond required for this project are shown in the attached table "Reclamation Bond Increase". Since this is only one of several projects impacting the bond, the numbers from this Appendix are incorporated with all others and shown in the main "Surety Bond Estimate", Table 3-3 of the M.R.P..

10/25/90

## HYDROLOGIC SUMMARY

### PROPOSED VENTILATION PORTAL

| | | |
|---|---|---|
| Proposed Undisturbed Drainage to Mine | - | 3.67 acres |
| Proposed Disturbed Drainage to Mine | - | 0.16 acres |
| Runoff Volume from 10/24 event (to Mine) | - | 0.24 ac. ft. |
| Additional Undisturbed Drainage to Pond | - | 3.79 acres |
| Additional Disturbed Drainage to Pond | - | 0.18 acres |
| Weighted Curve Number (Disturbed) | - | 78.50 |
| Weighted Curve Number (Undisturbed) | - | 72.00 |
| 10 yr. - 24 hr. Precipitation ($P_{10}$) | - | 2.40 in. |
| 10 yr. - 24 hr. Runoff ($Q_{10}$) (Disturbed) | - | 0.75 in. |
| yr. - 24 hr. Runoff ($Q_{10}$) (Undisturbed) | - | 0.48 in. |
| 25 . - 24 hr. Precipitation ($P_{25}$) | - | 2.90 in. |
| 25 yr. - 24 hr. Runoff ($Q_{25}$) (Disturbed) | - | 1.22 in. |
| 25 yr. - 24 hr. Runoff ($Q_{25}$) (Undisturbed) | - | 0.75 in. |
| Hydraulic Length of Watershed | - | 1100 ft. |
| Average Watershed Slope | - | 93.64 % |
| Time of Concentration | - | 0.06 hrs. |
| Peak Flow from 10/24 event (Pond) | - | 4.65 cfs |
| Peak Flow from 25/24 event (Pond) | - | 7.57 cfs |
| Runoff Volume from 10/24 event (Pond) | - | 0.16 ac. ft. |
| Additional Sediment Storage Req'd. | - | 0.01 ac. ft. |
| Additional Pond Capacity Req'd. | - | 0.17 ac. ft. |

**SWITCHBACK DIVERSION**

**PROPOSED VENTILATION PORTAL**

| | | |
|---|---|---|
| Peak Flow from 10 yr. - 24 hr. event (cfs) | - | 4.65 |
| Peak Flow from 25 yr. - 24 hr. event (cfs) | - | 7.57 |
| Ditch Slope (%) | - | 40.00 |
| Bottom Width (ft.) | - | 0.01 |
| Side Slope (h:v) | - | 2:1 |
| Manning's N | - | 0.035 |
| Velocity (fps) | - | 9.79 |
| )ow Depth (ft.) | - | 0.48 |
| R )ff CN | - | 78.5 |
| Area Req'd. (Sq. Ft.) | - | 0.48 |
| Min. Structure Area (Sq. Ft.) | - | 1.50 |

RECLAMATION BOND INCREASE
PROPOSED VENTILATION PORTAL

| ITEM | MAN/SHIFT | *1 COST/MAN SHIFT | LABOR COST | EQUIPMENT REQUIREMENTS | *2 SHIFT/COST | EQUIPMENT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|
| **Surface Facilities Removal** | | | | | | | |
| Portal Seal | 3/2 | 120 | 720 | Conc. Block | 1/1000 | 1000 | 1720 |
| Earthwork | 1/4 | 160 | 640 | Dozer | 4/703 | 2812 | 3452 |
| | 1/4 | 160 | 640 | Track Excavator | 4/954 | 3816 | 4456 |
| Revegetation | | | | | | | |
| Fertilization | 1/1 | 160 | 160 | Dozer | 1/703 | 703 | 863 |
| | | | | Spreader | 1/55 | 55 | 55 |
| | | | | Fertilizer | .340 ac @ 30/ac. | 10 | 10 |
| Seed Preparation | 1/1 | 160 | 160 | Dozer | 1/703 | 703 | 863 |
| | | | | Spreader | 1/55 | 55 | 55 |
| (Grassland-Shrub Area) | | | | Seed | .34 ac @ 388/ac | 132 | 132 |
| | | | | Land Imprinter | 1/200 | 200 | 200 |
| Contour Trenching | 1/1 | 160 | 160 | Dozer | 1/703 | 703 | 863 |
| Mulch | 10/1 | 1200 | 1200 | Erosion Mat. | .34 ac @1100/ac | 374 | 1574 |

10/25/90

RECLAMATION BOND INCREASE
PROPOSED VENTILATION PORTAL (continued)

| ITEM | MAN/SHIFT | *1 COST/MAN SHIFT | LABOR COST | EQUIPMENT REQUIREMENTS | *2 SHIFT/COST | EQUIPMENT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|
| **Miscellaneous** | | | | | | | |
| Supervision | 1/4 | 200 | 800 | N/A | N/A | N/A | 800 |

*1 - Cost Estimates From: Means 1984 Cost Construction Data, 42nd Annual Edition.

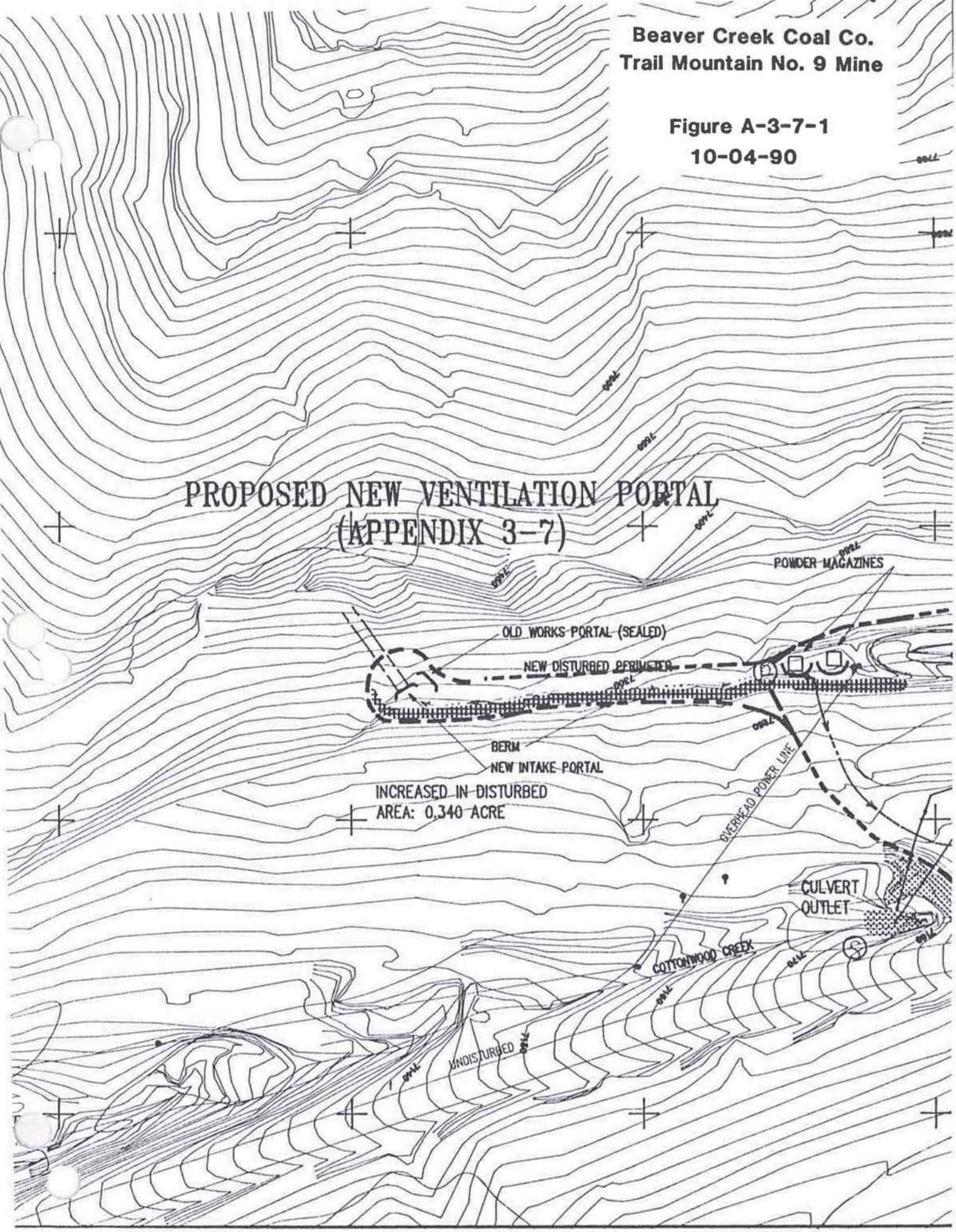
*2 - Cost Estimates From: Rental Rate Blue Book - Construction Equipment, 1983.

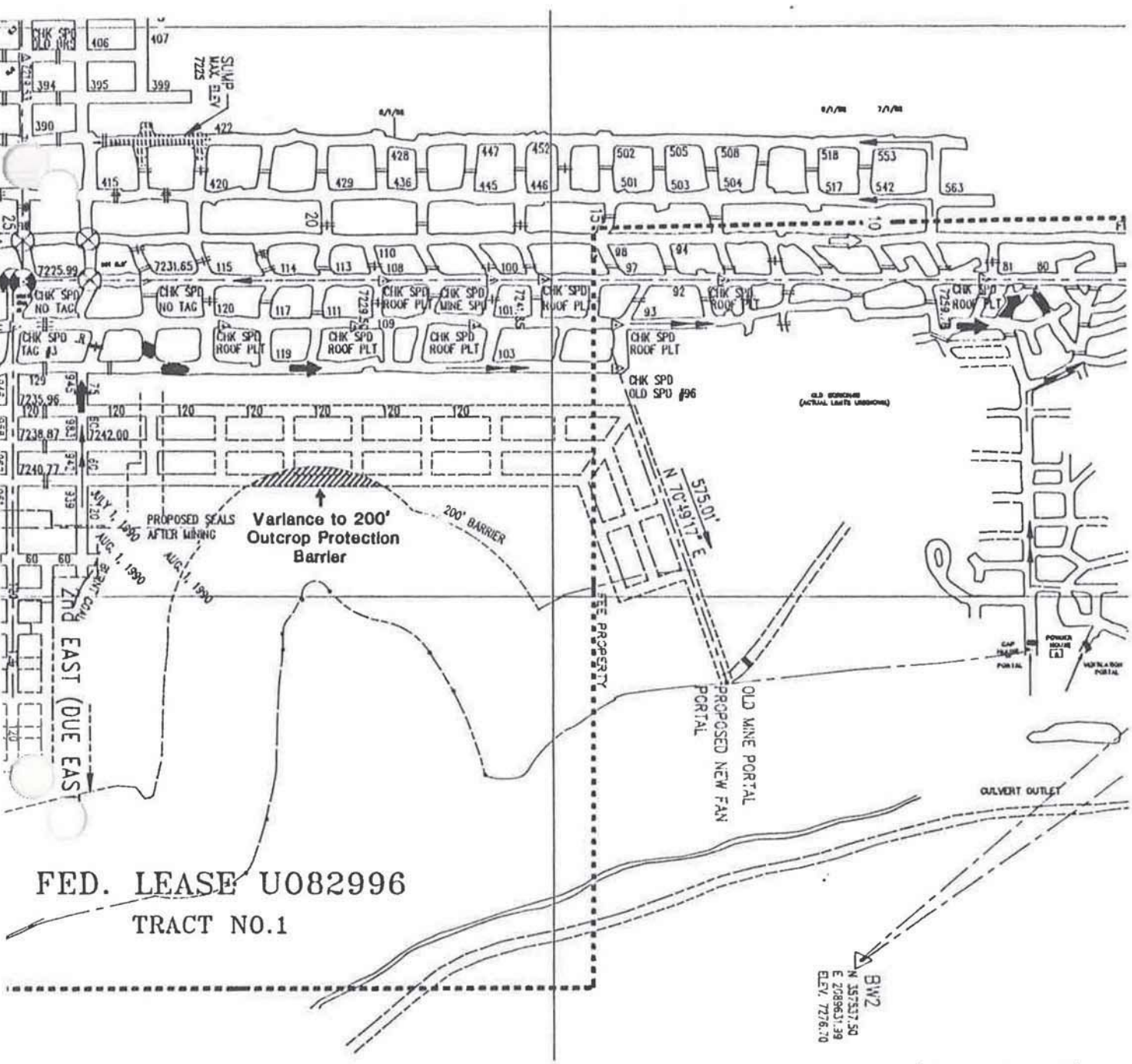
| | | |
|---|---|---|
| Sub - Total | = | $15,043 |
| +10.00% Contingency | = | 1,504 |
| **Total (1984 Dollars)** | = | **$16,547** |
| +6.78 Inflation (5yrs.) | = | 6,424 |
| **Total (1989 Dollars)** | = | **$22,971** |
| +6.78 Inflation (5yrs.) | = | 8,917 |
| **Total (1994 Dollars)** | = | **$31,888** |

10/25/90

**Beaver Creek Coal Co.**
**Trail Mountain No. 9 Mine**

**Figure A-3-7-1**
**10-04-90**





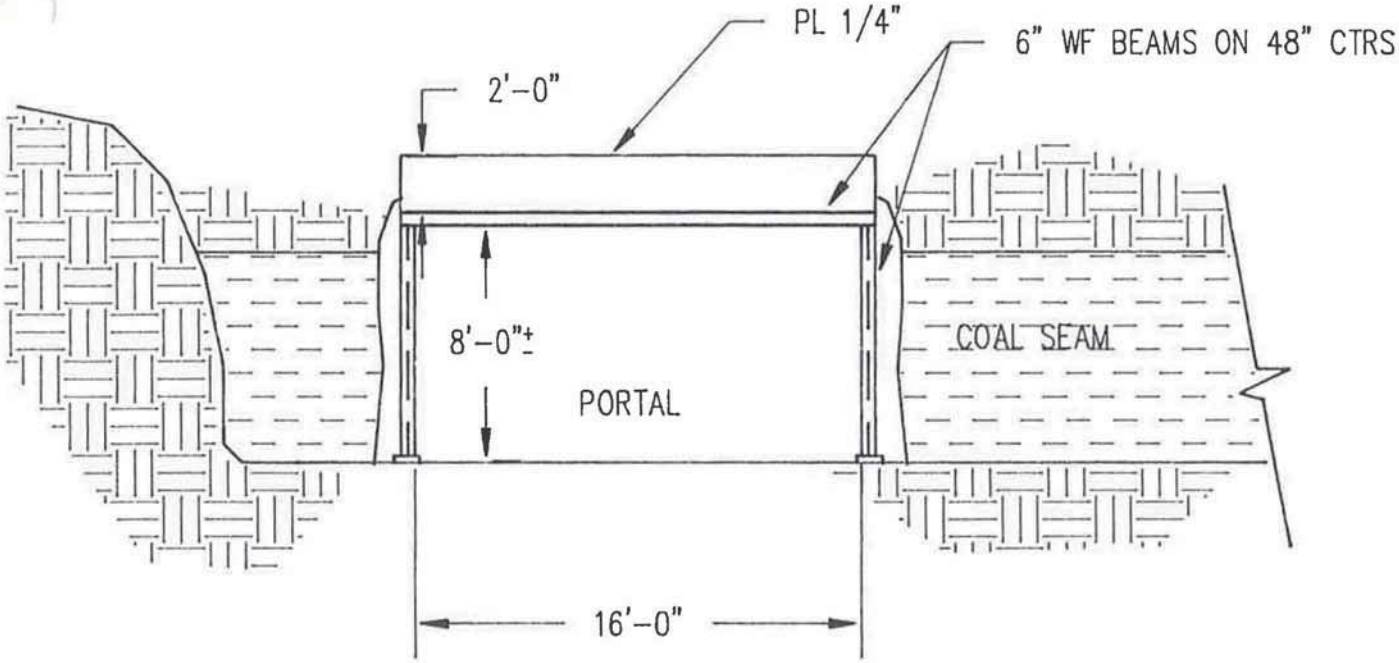

**Beaver Creek Coal Co.**
**Trail Mountain No. 9 Mine**

**Figure A-3-7-2**

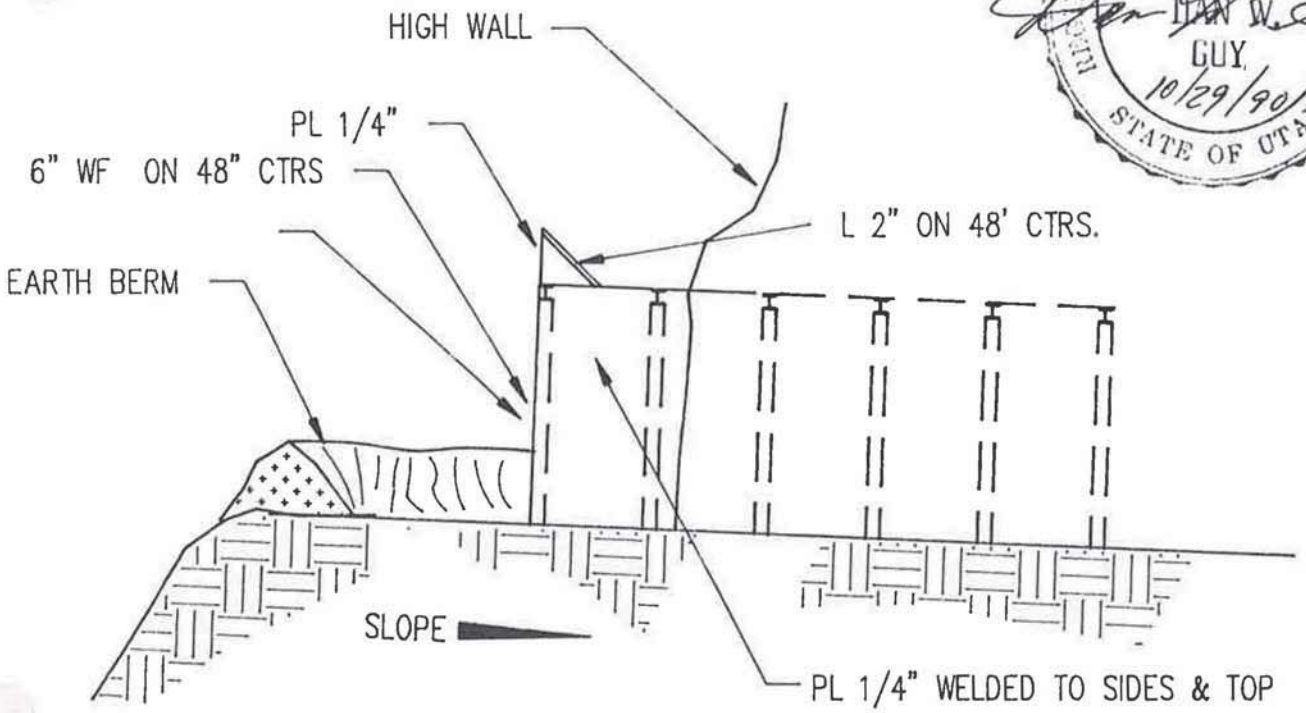
**10-04-90**

# PORTAL DETAIL
# NEW PORTAL AREA

DRN. BY: L.W.J. DATE: 10/02/90 PLOT @ 1"=10' N.T.S. FILE: D:\LWJ\9MINE\PERMIT\PORTDET.DWG




## FRONT VIEW

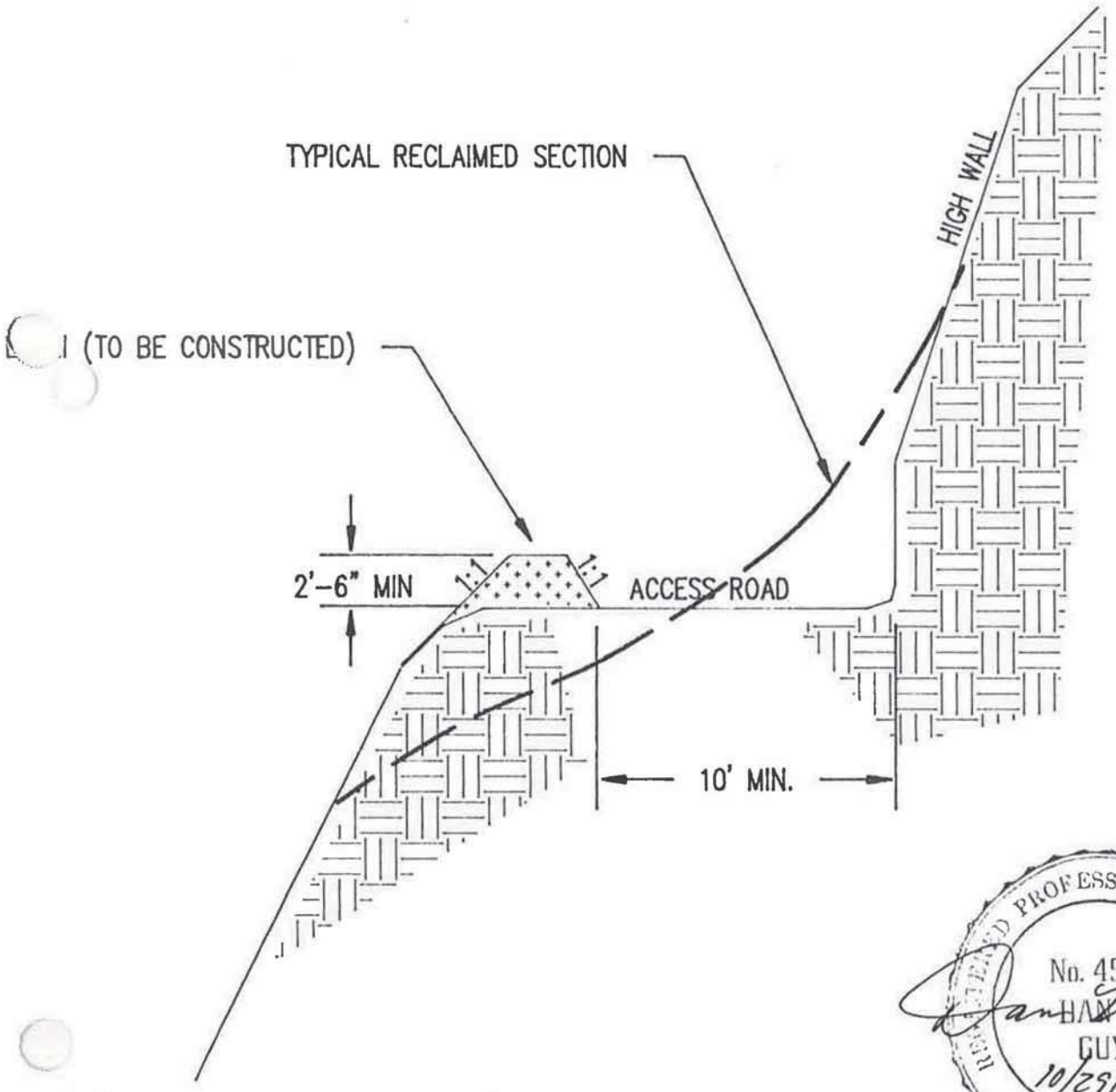



## SIDE VIEW

# TYPICAL ROAD SECTION
# for PROPOSED VENTILATION PORTAL

DRN. BY: L.W.J. DATE: 9/24/90

PLOTTED @ 1=1 N.T.S. FILE: D:\LWJ\9MINE\PERMIT\TYPSECT.DWG




REGISTERED PROFESSIONAL ENGINEER
No. 4548
JAMES W. GUY
10/29/90
STATE OF UTAH

# APPENDIX 5-8

# NEW COAL HANDLING FACILITIES

# APPENDIX 3-8

# PROPOSED COAL - HANDLING
# AND

# LOADOUT FACILITY

9/24/90

## Appendix 3-8

Trail Mountain No. 9 Mine
Proposed Coal Handling and Loadout Facility

General

The proposed project consists of total replacement of the existing coal handling facility, and the installation of a 600 ton storage bin and truck loadout. The existing tipple structure will be removed.

The following major items wil be modified or installed with this project:

(a) Relocate existing magnet;
(b) Install flop-gate to divert run-of-mine coal if needed;
(c) Bypass chute to ground storage;
(d) Install covered conveyor from crusher to bin;
(e) Install crusher;
(f) Install covered conveyor from crusher to bin;
(g) Install 600 ton storage/loadout bin;
(h) Control House;
(i) Truck scales;
(j) Upgrade transformers/electrical system as needed.

9/24/90

## Environmental Considerations

1- Disturbed Area

All work will be performed within the existing disturbed area.

2- Drainage Controls

Drainage controls will remain intact during the construction. All runoff is directed into the sediment pond.

3- Topsoil

N/A; Disturbed Area

4- Vegetation

N/A; Disturbed Area

5- Wildlife

All structures and modifications will be installed to minimize impacts to wildlife. Raptor protection will be installed if necessary.

6- Dust Control

This project will actually have a positive impact on dust control at this site. Water sprays will be used as needed at transfer points. Conveyors and transfer points will be covered. The most significant dust control measure will be the use of a bin for live storage and direct loading into the trucks. This will minimize the

need for open stockpiles and loaders at this site, which is considered to be a significant source of fugitive dust.

Operations Plan

The new coal handling/loadout system will provide a more efficient and environmentally sound system of handling and loading coal from the mine, and will replace the existing, outdated tipple and system of truck loading by front end loaders.

The general plan of operation is as follows:

Coal is brought to the surface by the main mine conveyor where the magnet removes any significant metal from the coal stream. The main conveyor discharges into a transfer equipped with a flop-gate. Under normal operating conditions, the coal is transferred onto the crusher-feed conveyor, passes through the crusher and is taken into the 600 Ton storage/loadout bin by the bin-feed conveyor. Trucks are then loaded directly from the bin and weighed to prevent overloading. If the bin is full, or a malfunction occurs on the primary system, the flop-gate can be thrown to divert the run-of-mine coal into a chute. This chute deposits the coal into a temporary open storage pile. Coal from this pile will be recovered by the loader and placed back into the system as possible.

## Reclamation Plan

Upon completion of operations, all structures will be removed, and the area will be reclaimed in accordance with the approved plan for the property.

## Other Agency Approvals Required

The only other agency approval anticipated for this project will be that of the Emery County Building Inspector. Required building permits will be obtained prior to construction.

## Construction Schedule

A contractor has been selected for this project, and engineering designs are being finalized. Actual construction is planned to start approximately 10/15/90 and be completed in early February 1991.

## Bond Revision

Calculations for the increase in the Reclamation Bond required for this project are shown in the attached table "Reclamation Bond Increase". Since this is only one of several projects impacting the bond, the numbers from the Appendix are incorporated with all others and presented in the main "Surety Bond Estimate", Table 3-3 of the M.R.P.

9/24/90

## RECLAMATION BOND INCREASE
## PROPOSED COAL HANDLING/LOADOUT FACILITY

| ITEM | MAN/SHIFT | *1 COST/MAN SHIFT | LABOR COST | EQUIPMENT REQUIREMENTS | *2 SHIFT/COST | EQUIPMENT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|
| **Surface Facilities Removal** | | | | | | | |
| Conveyor | 1/5 | 160 | 800 | Truck | 5/250 | 1250 | 2050 |
| | 1/5 | 160 | 800 | Crane | 5/381 | 1905 | 2705 |
| | 1/5 | 120 | 600 | None | - | - | 600 |
| Bin | 1/15 | 160 | 2400 | Truck | 15/250 | 3750 | 6150 |
| | 1/15 | 160 | 2400 | Crane | 15/381 | 5715 | 8115 |
| | 2/15 | 120 | 3600 | None | - | - | 3600 |
| Chute | 1/3 | 160 | 480 | Truck | 3/250 | 750 | 1230 |
| | 1/3 | 160 | 480 | Crane | 3/381 | 1143 | 1623 |
| | 1/3 | 120 | 360 | None | - | - | 360 |
| Scales | 1/2 | 160 | 320 | Truck | 2/250 | 500 | 820 |
| & Control House | 1/2 | 160 | 320 | Backhoe/Loader | 2/225 | 450 | 770 |
| | 2/2 | 120 | 480 | None | - | - | 480 |

Note: Revegetation and Miscellaneous costs are included in original Bond calculations.

| | | |
|---|---|---|
| Sub - Total | = | $28,503 |
| +10.00% Contingency | = | 2,850 |
| **Total (1984 Dollars)** | = | **$31,353** |
| +6.78% Inflation (5yrs.) | = | 12,171 |
| **Total (1989 Dollars)** | = | **$43,524** |
| +6.78% Inflation (5yrs.) | = | 16,896 |
| **Total (1994 Dollars)** | = | **$60,420** |

*1- Cost Estimates From: Means 1984 Cost Construction Data, 42nd Annual Edition.
*2- Cost Estimates From: Rental Rate Blue Book - Constuction Equipment, 1983.

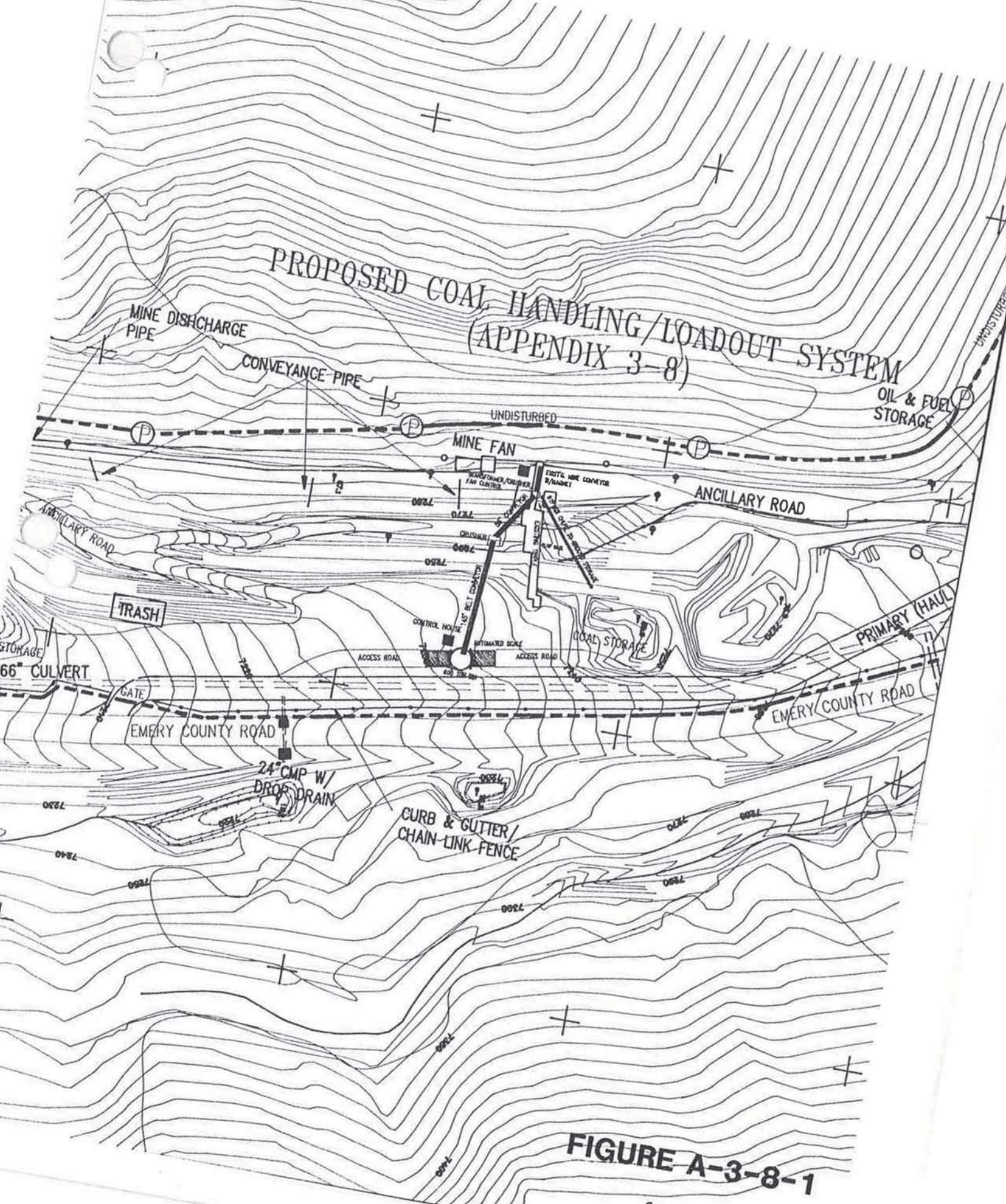



FIGURE A-3-8-1

9-24-90

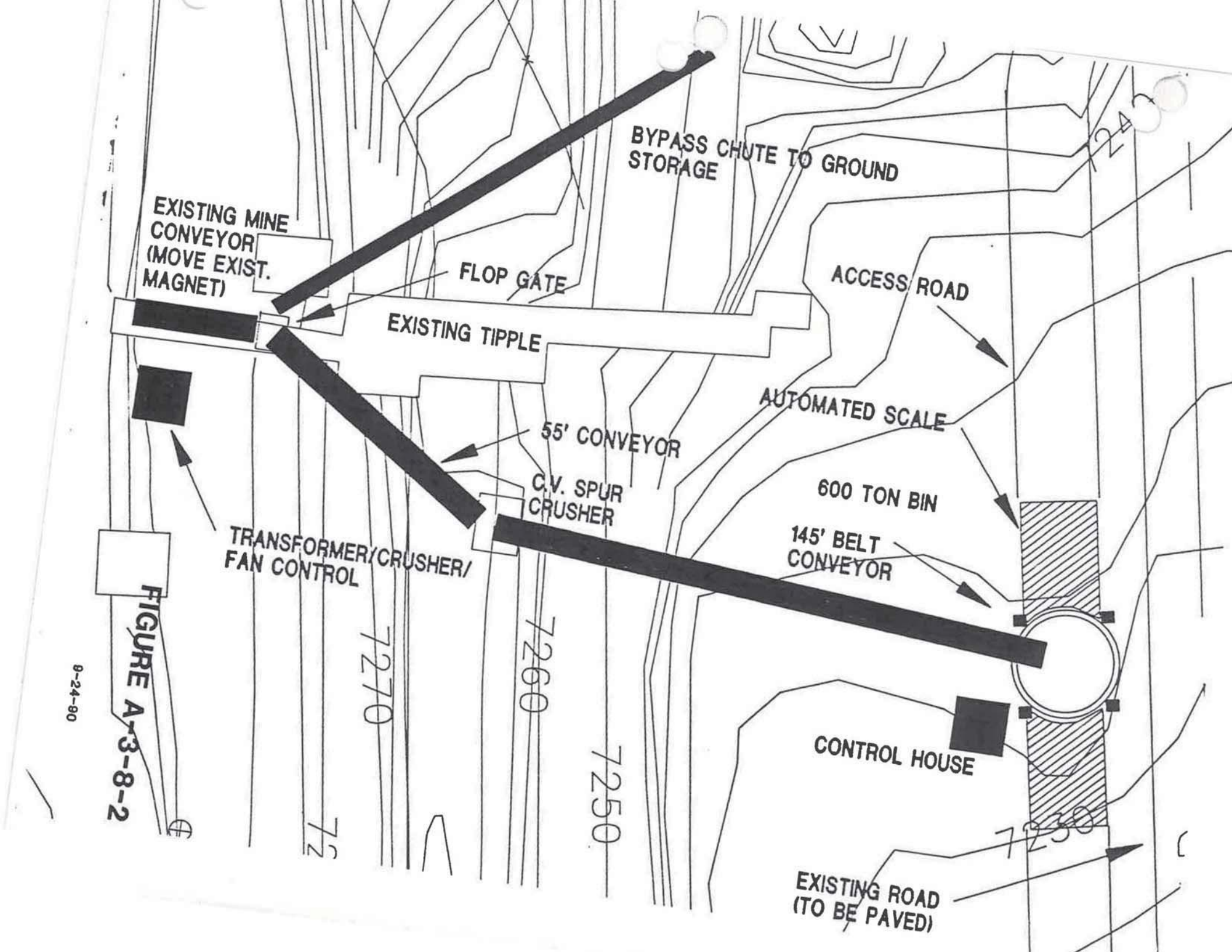

BYPASS CHUTE TO GROUND STORAGE
EXISTING MINE CONVEYOR (MOVE EXIST. MAGNET)
FLOP GATE
ACCESS ROAD
EXISTING TIPPLE
AUTOMATED SCALE
55' CONVEYOR
C.V. SPUR CRUSHER
600 TON BIN
TRANSFORMER/CRUSHER/ FAN CONTROL
145' BELT CONVEYOR
CONTROL HOUSE
EXISTING ROAD (TO BE PAVED)
7270
7260
7250
7230
9-24-90

FIGURE A-3-8-2

# COAL HANDLING FLOWCHART

: LWJ DATE: 10/02/90 PLOTTED @ 1=1 N.T.S. FILE: D:\LWJ\9MINE\PERMIT\CLFLOW.DWG

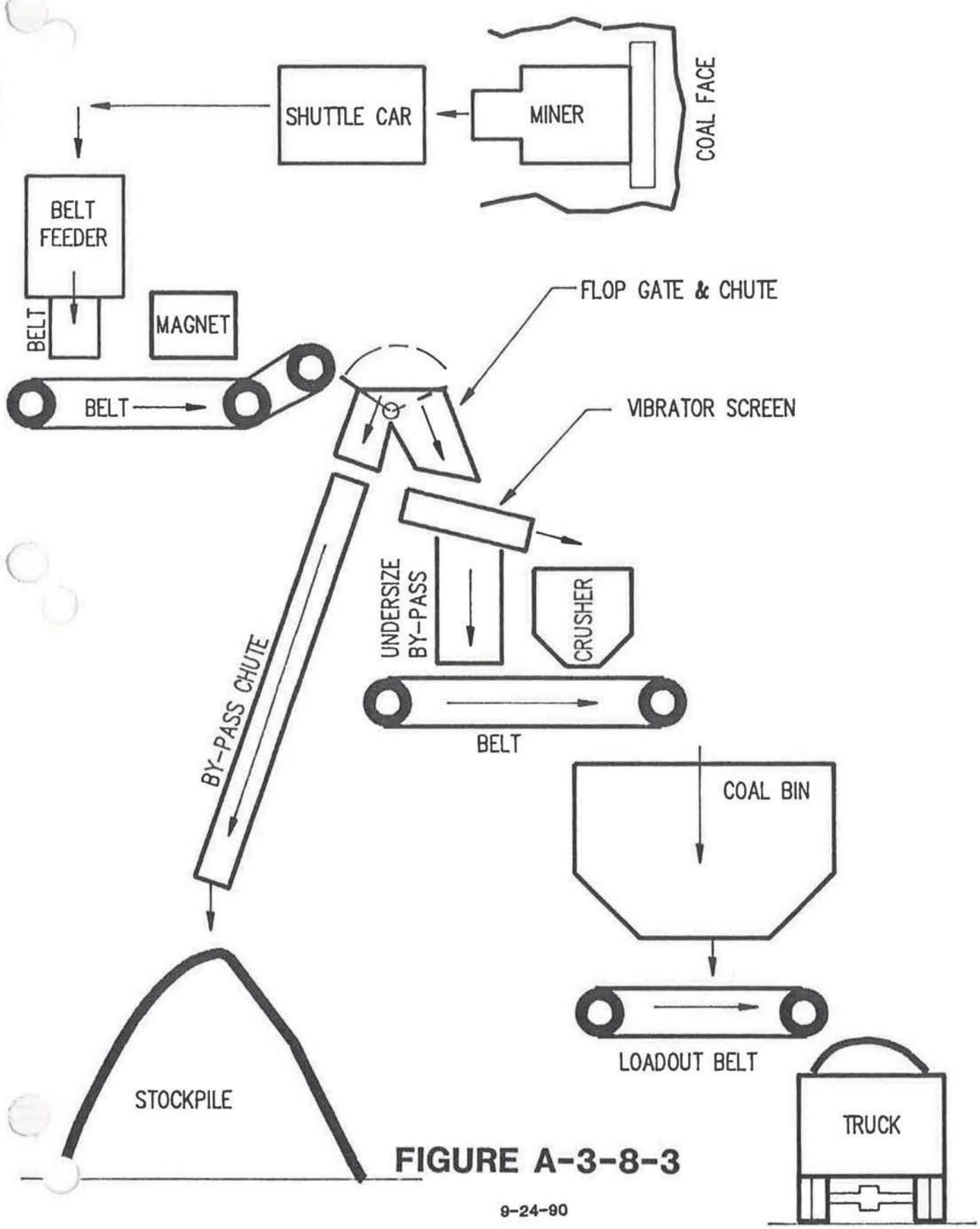



**FIGURE A-3-8-3**

9-24-90

# APPENDIX 5-9

# NEW BATHHOUSE AND CULINARY WATER

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 3-9

## PROPOSED NEW BATH HOUSE
## and

## CULINARY WATER SYSTEM

9/24/90

**Appendix 3-9**

**Trail Mountain No. 9 Mine**

**Proposed New Bath House / Culinary Water System**

General

This project will consist of placement of a new bath house facility and culinary water system for the Trail Mountain No. 9 Mine.

The bath house to be installed is that which presently serves the Gordon Creek No. 2/7/8 Mine properties. It will be located just north of the existing Office/Shop/Warehouse complex at No. 9 Mine. Removal of the vegetation test plots will be necessary to accommodate this structure.

The culinary water system will consist of placement of 3-10,000 gallon supply tanks at the north end of the property. These tanks will feed a culinary treatment plant located adjacent to the bath house, which in turn, will feed a 10,000 gallon culinary supply tank which will provide culinary water as needed to the facilities.

The bath house and culinary water expansion are required to accommodate the additional people to be transferred to this property from the Gordon Creek No. 8 Mine, which is scheduled to be closed in October - November, 1990.

Environmental Considerations

1- Disturbed Area All work will be performed within the existing disturbed area; therefore, no increase in disturbance

will result. Any additional disturbed area will result from the culvert extension project which will be completed prior to placement of these facilities.

2- Drainage Controls

Although the pad and parking area will have been expanded and regraded as a result of the culvert extension, the general drainage control for this area will remain the same as presently exists. All disturbed area runoff will be directed into the curb & gutter system and into the sediment pond. Undisturbed runoff will remain as presently exists (with the exception of the portion where the culvert is extended).

3- Topsoil

The proposed project will be within the disturbed area; therefore, no topsoil is available to be saved. The vegetation tests plots are in pre-disturbed soils. The soil from the test plots will be salvaged at least to the depth of the plant roots, and placed in the topsoil storage area. The stored soil will be reseeded in accordance with the approved plan for Contemporaneous REclamation. The topsoil pile is also protected by a silt fence around the entire pile.

4- Vegetation

The only vegetation involved with this project will be that on the test plots. Since the plot test is now terminated, and the area will be used as pad & parking no revegetation is proposed for this project until final reclamation.

5- Wildlife

This project should have no negative effects on wildlife, since it will utilize existing disturbed area. Any new power poles will be equipped with raptor protection as necessary.

6- Dust Control

The parking area will be graveled and sprinkled or otherwise treated to minimize dust. The area will also be sprinkled as needed to minimize dust during construction.

Operations Plan

The culinary water system will be supplied raw water from Cottonwood Creek and/or underground mine water. This water will be stored in the 3-10,000 gallon tanks. These tanks will gravity feed to the culinary water treatment plant. The tanks can also supply water to the shop steam cleaner, underground water and water for yard dust control.

The culinary water plant will treat the raw water at a rate of approximately 10 gpm. This treated water is pumped into the 10,000 gallon culinary storage tank, which supplies culinary water to all required sites. The general schematic for operation of the culinary water system is shown on Figure 3-4 of the M.R.P..

The bath house will receive water from the culinary tank only. This water is heated in the bath house water heaters and supplied to the showers and lavatory facilities. The bath house is set up to

service approximately 100 to 120 people on a daily basis.

Sewage from the new bath house will be tied into the existing wastewater line in the old bath house facility. This will only be an extension of the inlet line, and since it is a replacement of facilities (the old facilities will be eliminated) it doesn't constitute a major change to the approved system.

## Reclamation Plan

Upon completion of operations, all structures will be removed, and the area will be reclaimed in accordance with the approved plan for the property. There are no plans for contemporaneous reclamation in conjunction with this project; however, the highwall area behind the bath house will be reseeded as part of the culvert extension project.

## Other Agency Approvals Required

The culinary water treatment facility must be approved by the Utah Health Department. Only an approved system will be used.

Required building permits will be obtained from Emery County prior to construction.

## Construction Schedule

The construction of the bath house and culinary water system is projected to start after the 66" culvert is extended, and backfilled. This is anticipated to be approximately 11/15/90. Construction should be complete within 3 - 4 weeks after that time.

**Bond Revision**

Calculations for the increase in the Reclamation Bond required for the project are shown in the attached table "Reclamation Bond Increases". Since this is only one of several projects impacting the bond, the numbers from this appendix are incorporated with all others and presented in the main "Surety Bond Estimate", Table 3-3 of the M.R.P..

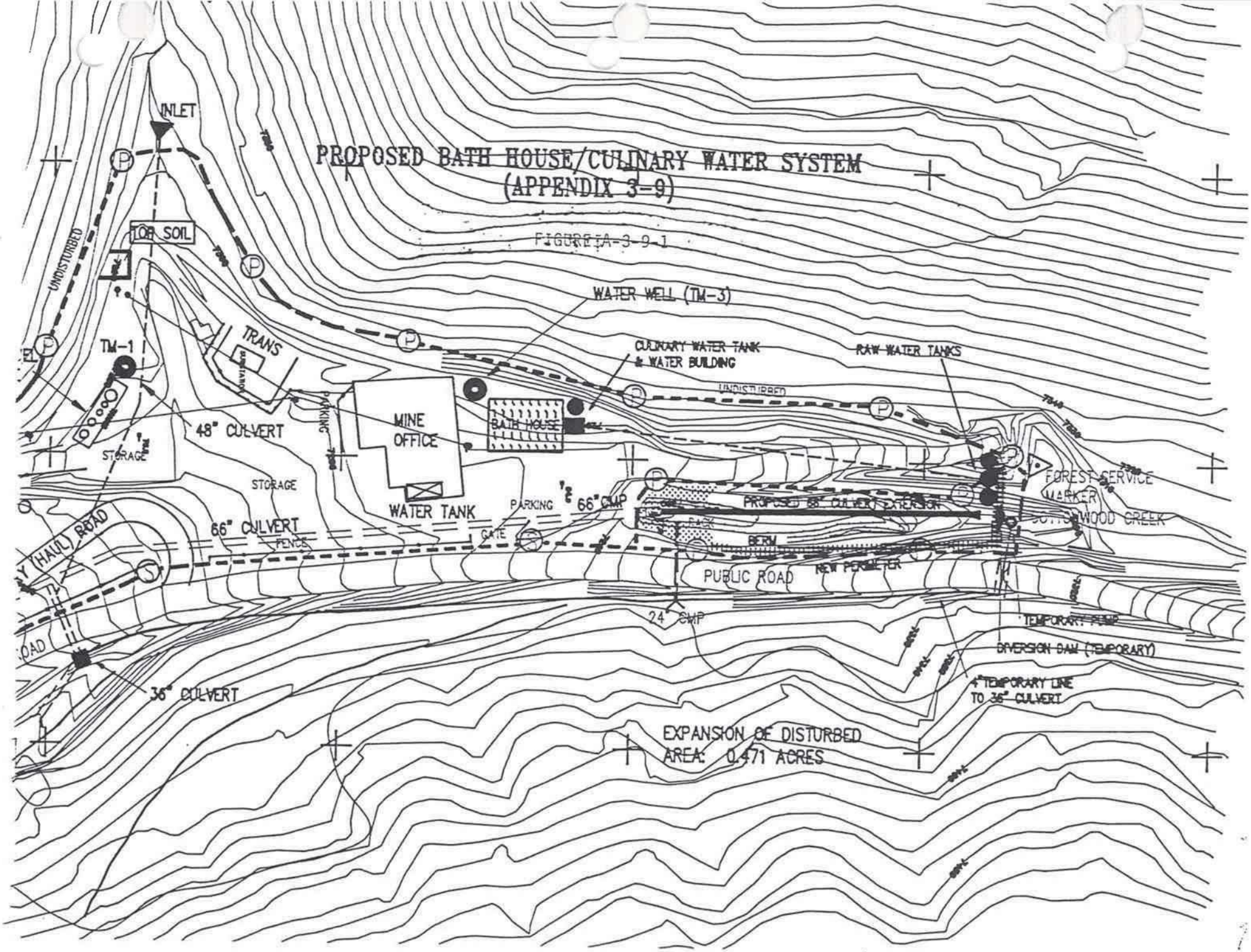
RECLAMATION BOND INCREASE
PROPOSED NEW BATH HOUSE / CULINARY WATER SYSTEM

| ITEM | MAN/SHIFT | *1 COST/MAN SHIFT | LABOR COST | EQUIPMENT REQUIREMENTS | *2 SHIFT/COST | EQUIPMENT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|
| **Surface Facilities Removal** | | | | | | | |
| Bath House | 1/4 | 160 | 640 | Truck | 4/250 | 1000 | 1640 |
| | 1/4 | 160 | 640 | Back/Loader | 4/225 | 900 | 1540 |
| | 2/4 | 120 | 960 | None | - | - | 960 |
| Water System | 1/2 | 160 | 320 | Truck | 2/250 | 500 | 820 |
| | 1/2 | 160 | 320 | Back/Loader | 2/225 | 450 | 770 |
| | 1/2 | 120 | 240 | None | - | - | 240 |

| | | |
|---|---|---|
| Sub - Total | = | $ 5,970 |
| +10.00% Contingency | = | 597 |
| Total (1984 Dollars) | = | $ 6,567 |
| +6.78 Inflation (5yrs.) | = | 2,549 |
| Total (1989 Dollars) | = | $ 9,116 |
| +6.78 Inflation (5yrs.) | = | 3,539 |
| Total (1994 Dollars) | = | $12,655 |

Note: Revegetation and Miscellaneous costs are included in original Bond calculations.

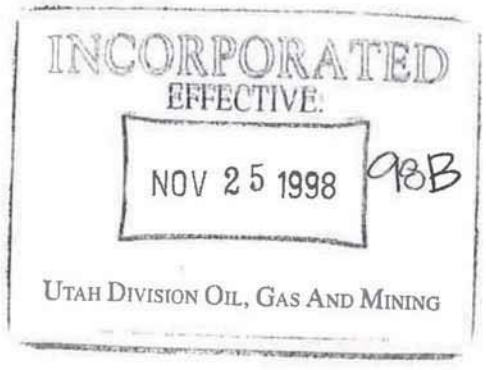
*1- Cost Estimates From: Means 1984 Cost Construction Data - 42nd Annual Edition.
*2- Cost Estimates From: Rental Rate Blue Book - Construction Equipment, 1983.


PROPOSED BATH HOUSE/CULINARY WATER SYSTEM
(APPENDIX 3-9)
FIGURE A-3-9-1
INLET
TOP SOIL
UNDISTURBED
TM-1
TRANS
48" CULVERT
STORAGE
WATER WELL (TM-3)
CULINARY WATER TANK
& WATER BUILDING
RAW WATER TANKS
UNDISTURBED
MINE
OFFICE
BATH HOUSE
PARKING
WATER TANK
66" CMP
66" CULVERT
FENCE
GATE
PROPOSED 66" CULVERT EXTENSION
BERM
PUBLIC ROAD
NEW PERIMETER
24" CMP
FOREST SERVICE
MARKER
WOOD CREEK
TEMPORARY PUMP
DIVERSION DAM (TEMPORARY)
4" TEMPORARY LINE
TO 36" CULVERT
36" CULVERT
EXPANSION OF DISTURBED
AREA: 0.471 ACRES

# APPENDIX 5-10

# FACILITY MODIFICATIONS AND ADDITIONS

# Appendix 3-10
# Facility Modifications And Additions



**Operation Plan for Facility Modification and Additions**

Following is a list of facility modifications and additions. All structures are shown on Figure 3-1.

(a) Blowing Fan – A blowing fan and concrete portal liner was installed in the old access portal in 1993 and 1994.

(b) Fuel Storage Area – the fuel storage area was removed in 1993 to allow construction for the new access portal.

(c) Belt Portal – the existing belt portal was modified in 1993 with a concrete portal liner.

(d) South Return Portal – The existing south portal was modified in 1993 with a concrete portal liner.

(e) North Return Portal – The existing fan (pre-1993) portal was modified in 1993 by removing the fan and lining the portal with a concrete portal liner.

(f) Pumphouse and Water Tank – A new high pressure pumphouse and water tank system was added in 1993. This facility supplies water underground to be used for mining operations.

(g) Access Portal – A new access portal for transportation of men, equipment and materials was constructed in 1993.

(h) Water Treatment Plant – The water treatment plant was relocated from the parking area to an area adjacent to the pumphouse and water tank in 1994.

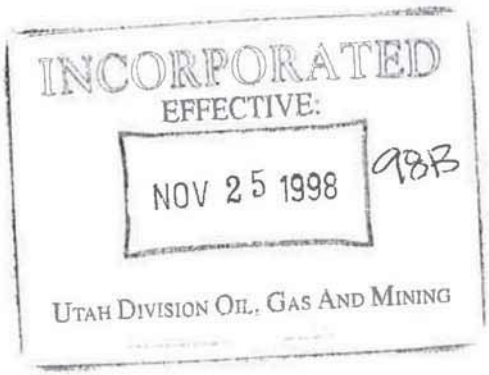
(i) ROM Transfer – The ROM Transfer was relocated slightly and structural changes were done in 1994.

INCORPORATED
EFFECTIVE:
NOV 25 1998
UTAH DIVISION OIL, GAS AND MINING

(j) Tipple Electrical Facility – the Tipple Electrical Facility was removed from the upper bench and a new building was built on the crusher bench in 1994.

(k) ROM Tube Conveyor – The ROM Tube Conveyor from Trail Mountain Mine to Cottonwood Mine was constructed in 1994 and 1995.

(l) Salt Storage Shed – The covered Salt Storage Shed was constructed in 1998.

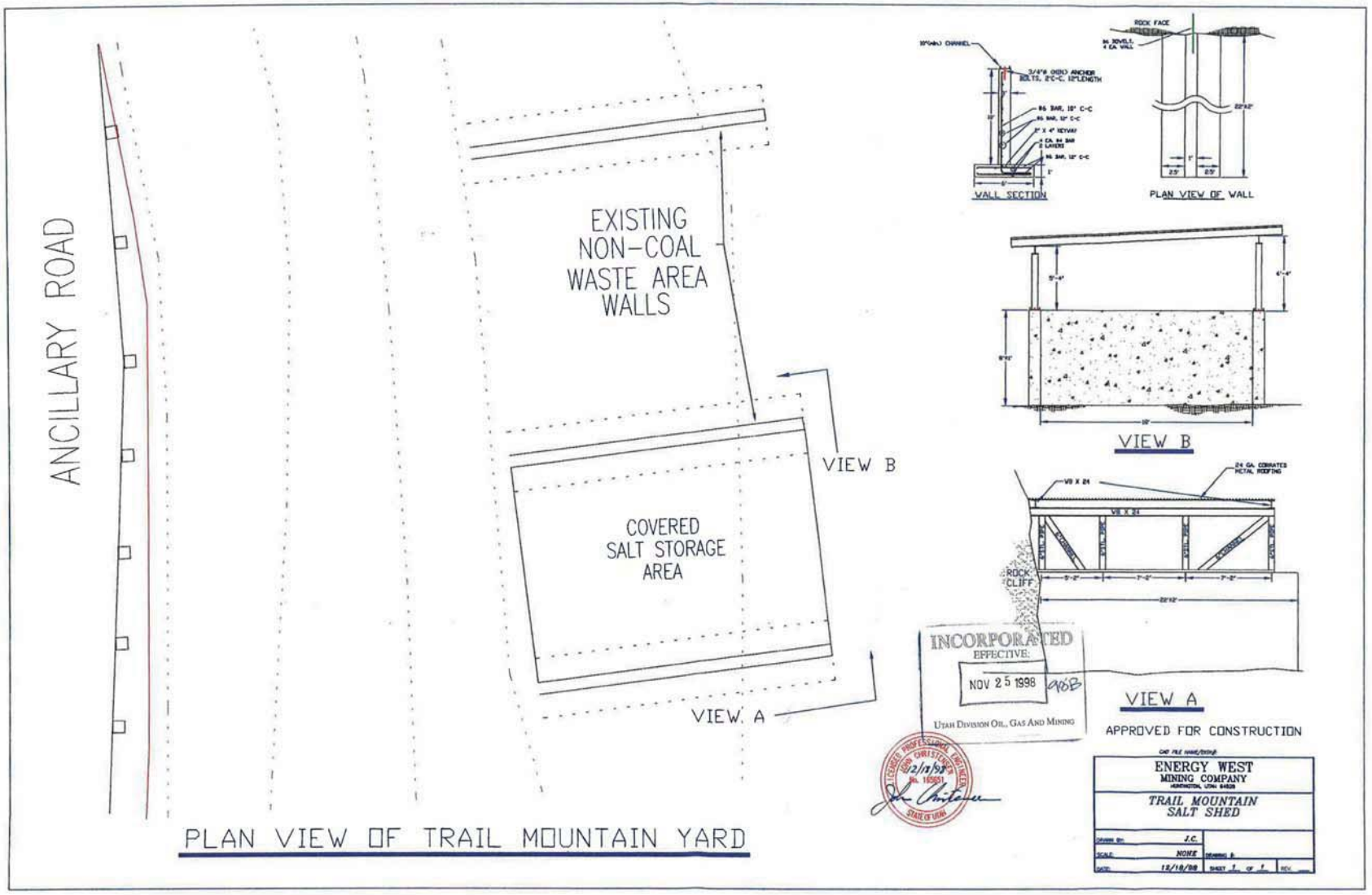


## TOPSOIL HANDLING

The proposed additional disturbance associated with the surface facilities amendment will impact a portion of the Blackhawk Formation which overlies the coal seam. The Blackhawk Formation, in this area, consists of closely-jointed, thin-bedded, heavily-weathered sandstones, siltstones and shales covered by a thin layer of colluvium.

As discussed on Pages 8-7 and 8-10 through 8-12 of the Trail Mountain MRP, soil in the area of the proposed disturbance is very limited, with only approximately 5 inches (13 cm) of, what might be considered, topsoil. The total depth of soil material in the area is less than 20 inches (50 cm).

Removal and salvage of the "topsoil" would require extensive disturbance which is not justified by the small amount of material that would be recovered. Therefore, the soil materials will be removed with the underlying weathered materials and disposed of in the approved Cottonwood waste rock site as excess overburden material.




PLAN VIEW OF TRAIL MOUNTAIN YARD

APPENDIX 5-11

MUNICIPALITY CORRESPONDENCE

# APPENDIX 3-11
# MUNICIPALITY CORRESPONDENCE

INCORPORATED

JUN 27 2018

Div. of Oil, Gas & Mining

EMERY COUNTY

**Road Department**

February 4, 2015

PacifiCorp
15 North Main Street
P. O. Box 310
Huntington, Utah 84528
Dennis Oakley
Senior Mine Engineer

Mr. Oakley,

PacifiCorp has a water discharge line draining from the Cottonwood Mine/Trail Mt. access portal. Currently this line is buried under the bar ditch and draining into a drop box and culvert structure crossing county road #506. Emery County Road Department wishes to leave this in place as is to better facilitate maintenance. Leaving the line underground will keep ice from building up in the winter. Emery County will maintain this line as our own from now on.

Sincerely,
Wayde S. Nielsen

Wayde S. Nielsen
Emery County Road Supervisor

INCORPORATED

JUN 27 2018

Div. of Oil, Gas & Mining

Box 889 300 West SR29 Castle Dale, Utah 84513 Telephone (435) 381-3510 FAX (435) 381-5239

APPENDIX 5-11-1

LIMITED SECOND MINING AREA

# APPENDIX 11-1

# LIMITED SECOND MINING AREA

STATE OF UTAH
NATURAL RESOURCES
State Lands & Forestry

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
Ralph A. Miles, Division Director

North Temple • 3 Triad Center • Suite 400 • Salt Lake City, UT 84180-1204 • 801-538-5508

July 29, 1985

Allen P. Childs, Engineer
Trail Mountain Coal Company
P. O. Box 370
Orangeville, UT 84537

SUBJECT: ML 22603 Coal

Dear Mr. Childs:

Thank you for your letter of July 11th. I have had opportunity to briefly discuss your subsidence barrier problem with Mr. John Whitehead of the Division Oil, Gas & Mining. Mr. Whitehead indicated that Division Oil, Gas & Mining would be willing to consider an amendment to the mine plan in this matter.

You should send a formal request addressed to John Whitehead, Division Oil, Gas & Mining, asking that your approved mine plan be amended. Your request should indicate proposed change in the angle of draw, etc., and be technically justified with supporting studies or documentation. Remember, United States Forest Service has no jurisdiction over this land. Your mine plan should therefore seek maximum coal recovery within the limits of acceptable mining practices and Division Oil, Gas & Mining regulations. Also, indicate what time constraints you may be under to have the amendment approved.

I appreciate your interest and concern with recovering as much coal as possible from the State lease. I believe that mine plan amendment is the most expedient course of action to pursue. Land exchanges with the Federal Government are sometimes difficult to achieve. Please let me know if I may be of further assistance to your effort.

Sincerely yours,

John T. Blake

JOHN T. BLAKE
MINERALS RESOURCE SPECIALIST

JTB/jg

November 14, 1985
8185 South Willow Street
Englewood, CO 80112

Mr. Allen Childs
Trail Mountain Coal Company
PO Box 370
Orangeville, Utah 84537

Dear Mr. Childs:

I have completed the work requested in regards to the coal pillar strength calculations and have included my conclusions which will permit secondary mining in the area east of the South Mains and still afford adequate escarpment protection. Please accept this letter as a draft copy for your review and comment.

Results

The overburden directly over the First South Submains and the barrier pillar between the First South Submains and the South Mains ranges from 500 feet to 1350 feet. The 60 x 60 foot pillars developed on the advance can be reduced to a size of 47 x 60 foot if a factor of safety of 1.5 is maintained under the area of maximum cover.

The overburden directly over the Second South Submains and the unmined coal to the east ranges from approximately 200 feet to 850 feet. The 60 x 60 foot pillars developed on the advance can be reduced to a size of 40 x 60 foot in areas that the overburden remains under 700 feet if a factor of safety of 1.5 is to be maintained. In areas where the overburden is in excess of 700 feet I would revert back to the 47 x 60 foot recovery plan.

As secondary recovery is conducted on the pillars within the First East, First and Second North Submains I would follow the same pillar extraction plan as outlined above.

I recommend using a factor of safety equal to 1.5 for design coupled with the conservative physical properties of the coal used in the ensuing calculations as limited technical data is available.

I have included the linears determined by Mr. Thomas Johnson on Plate I. I don't believe any lost recovery will be experienced due to their presence in the submains. However, it may warrant leaving 47 x 60 foot pillars in some areas in the panels driven eastward from the Second South Submains to limit the area of unsupported roof.

Discussion

The area of interest is the block of unmined coal lying to the east of the South Mains at the Trail Mountain Coal Mine. The following study was completed to develop a mining plan to maximize the coal recovery within this area from the originally submitted plan and still afford adequate support to prevent catastrophic subsidence and escarpment failure.

The average coal thickness was determined in the Mining and Reclamation Plan, Trail Mountain Mine, Volume 1, Appendix 3 dated June 1984 to be 6.8 feet plus or minus 0.9 feet obtained by weighting the samples distributed along the eastern and southern limbs of the coal outcrop to the same level of influence as those to the north. Based upon the Garnet program maintained by the National Coal Resources Data System, the Hiawatha Seam averages approximately 6.9 feet in thickness within the Trail Mountain Tract as shown on Figure 6 of the aforementioned report. An average coal seam thickness in the area east of the South Mains was calculated to be 6.9 feet based upon the surveying information supplied by Mr. Bruce Ware by averaging data points measured in the South Mains and 1st East Submains. A coal seam thickness of 7 feet will be used throughout this report which will produce slightly conservative values.

Plate I accompanying this letter was prepared and serves as the basis for several ensuing calculations. Information used to create Plate I was obtained from the following sources:

a) The mine development, coordinate grid lines, mine plan projections, underground seam elevations, seam thicknesses and the Hiawatha Seam outcrop were obtained from the Trail Mountain Coal Company, Trail Mountain Mine Ventilation Map dated March 1, 1985 as prepared by Mr. Bruce Ware.

b) The coal outcrop south of N353000 was taken from the Natomas Coal Company, Coal Isopach Map as prepared by Mr. Don Schofield dated June 1981.

c) The linears as plotted on Plate I were obtained from a February, 1982 report prepared by Thomas Johnson called Occurrence of Sandstone Spar in the Trail Mountain Coal Mine, Emery County , Utah.

The overburden isopachs as shown on Plate I were generated from the mine elevations as determined from underground surveys, the coal outcrop location as previously described and the surface topography obtained from the Hiawatha USGS Quadrangle map. Isopachs were drawn at 200 foot intervals ranging from 0 feet at the outcrop to approximately 1350 feet in areas along the eastern boundary of the South Mains. All results from calculations are shown at 100 foot overburden increments beginning with the out-

crop and finally at 1350 feet, the maximum overburden depth.

A 200 foot solid barrier pillar will be left intact along the outcrop as shown on Plate I. The 200 foot limit was suggested by Messrs. Boyd McKeen and Jackson Moffitt with the Bureau of Land Management.

The barrier pillar on the southern boundary of Section 36 in the area east of the South Mains will be 100 feet wide as shown on Plate I. The pillar was designed according to Utah mining regulations, based upon the following formula:

$$\text{Width} = 2 * C + 5 * OVB / 100 + 10$$

C = Coal thickness to be extracted in feet
OVB = Overburden depth in feet

The maximum overburden along the southern border is equal to 1200 feet in the area of the South Mains which requires a minimum pillar width of 84 feet.

Rooms and entries are to be driven on 80 foot centers which would leave a nominal 60 by 60 foot square pillar for overburden support during as the headings are advanced. Secondary mining will result in leaving either 40 by 60 foot or 47 by 60 foot pillars in place to prevent subsidence and provide adequate overburden support.

The pillar load carrying capacity in short tons will be determined at different overburden depths for a variety of pillar sizes ranging from 40 by 40 foot to 60 by 60 foot based upon the work of Wilson and Ashwin. A brief description of the method, calculations and assumptions that were incorporated will be presented:

Wilson and Ashwin propose that a remnant pillar contains a yield zone near the pillar edges and a core in the center enclosed by the yield zone. The maximum stress distribution that causes pillar failure is zero at the rib and increases linearly inward for a distance "Y" to a point where stress is maximum and equals the yield limit. The yield stress is constant across the core. The load carrying capacity of the pillar is determined by the following equations:

Square Pillar

$$L=7.2 * 10^{-2} * SV * (W^2 - 2 * W * Y + 4 * Y^2/3)$$

Rectangular Pillar

$$L=7.2 * 10^{-2} * SV * (W * Le - W * Y - W * Le + 4 * Y^2/3)$$

where:

SV = $6.94 * 10^{-3} * D * OVB * TANB + CS$
D = 144 $lb/ft^3$, density of overburden
OVB = 0 to 1350 feet, depth of overburden
TANB = (1+sin I)/(1-sin I), coefficient
I = 30 to 40 degrees, angle of internal friction
CS = 800 to 4600 psi, confining stress pillar edge
W = 40 to 60 feet, pillar width
Le = 40 to 60 feet, pillar length
Y = distance to maximum pillar stress, feet
= $\ln(SV/CS) * M / (TANB^{1/2} * (TANB - 1))$
M = 7 feet, mining height
W > 2 * Y

Coal exhibits typical values for the internal angle of friction within the range of 30 to 40 degrees. A value of 32 degrees was used in all calculations which is exhibited by pillars that are moderately to highly jointed. The pillars observed at the Trail Mountain Mine appear to be moderately jointed but due to the lack of test data a conservative approach is warranted by selecting a value of 32 degrees for "I".

The confining stress acting at the edge of coal pillars, the rock mass cohesion "CS", ranges from 800 to 4600 psi. The rock mass cohesion was assumed to be 800 psi based upon the uniaxial compressive strengths of the Hiawatha Seam coal as tabulated in Exhibit C.

A factor of safety of 1.5 was applied to the calculated load carrying capacity of the pillar to determine the pillar design stress. The design stress was compared to the tributary load pillar stress and the allowable overburden depth was determined as shown in Exhibits 1 and 2.

The results of the above calculations, while maintaining a minimum factor of safety of 1.5, are presented in the table below:

| Pillar Size | App. Recovery | Overburden |
|---|---|---|
| 40 x 60 | 63% | 685 Feet |
| 47 x 60 | 56% | 1330 Feet |

I confirmed the above results by using two other methods that are presented in Exhibits 3 and 4. Exhibit 3 was based upon actual uniaxial compressive strengths obtained from the Hiawatha Seam and the procedure developed by Skelly, Wolagmott and Wang. Exhibit 4 is based upon the calculation procedure outlined by Peng. The maximum overburden depth adequately supported by a 40 x 60 foot pillar is 800 feet and by a 47 x 60 pillar is 1350 feet.

In Section 12-B of the Mining and Reclamation Plan, Trail Mountain Coal Company, Volume 2 dated June 1984, Figure 12-5 labeled as the Subsidence Monument Plan prepared on March 12, 1984, the location of the surveying stations to be installed using 5/8 inch rebar are shown in the vicinity of the 1st and 2nd South Submains. The 16 stations will be monitored for horizontal and vertical control in accordance with the subsidence monitoring program. The support provided by the remaining pillar should prevent escarpment failure due to coal removal.

Bibliography

I have included the following bibliography if it is needed for DOGM to complete their approval of the proposed plan:


Abel, J.F. and Lee, F.T., Subsidence Potential in Shale and Crystalline Rocks, Open File 80-1072, USGS, 1980, 49 p.

Cummins, A.B. et al., SME Mining Engineering Handbook, Vols. 1 and 2, Port City Press, Baltimore, 1973.

Davis, F.D. and Doelling H.H., Coal Drilling at Trail Mountain, North Horn Mountain, and John Peak Areas, Wasatch Plateau, Utah, Bulletin 112, UGMS, 1977, 90 p.

Gurgel, K.D., Proceedings, Fifth Symposium on the Geology of Rocky Mountain Coal 1982, UGMS, Bulletin 118, 1982.

Hustrulid, W.A., A Review of Coal Pillar Strength Formulas, Rock Mechanics, Vol. 8, 1976, p. 75-80.

Hustrulid, W., Subsidence Workshop in Salt Lake City, Mine Subsidence Workbook, 1980, 84 p.

Johnson, T.L., Occurrence of Sandstone Spar in the Trail Mountain Coal Mine, Emery County, Utah, Natomas Coal Company Report, 1982, 39 p.

Peng, S.S., Coal Mine Ground Control, John Wiley & Sons, NY, 1978, 450 p.

Skelly, W., Wolagmott, J. and Wang, F., Coal Mine Pillar Strength and Deformation Prediction Through Laboratory Sample Testing, Proceedings 18th Symp. Rock Mechanics, Keystone, CO, June 1977, 5 p.

Trail Mountain Coal Company, Mining and Reclamation Plan, including various updates, as submitted to DOGM.

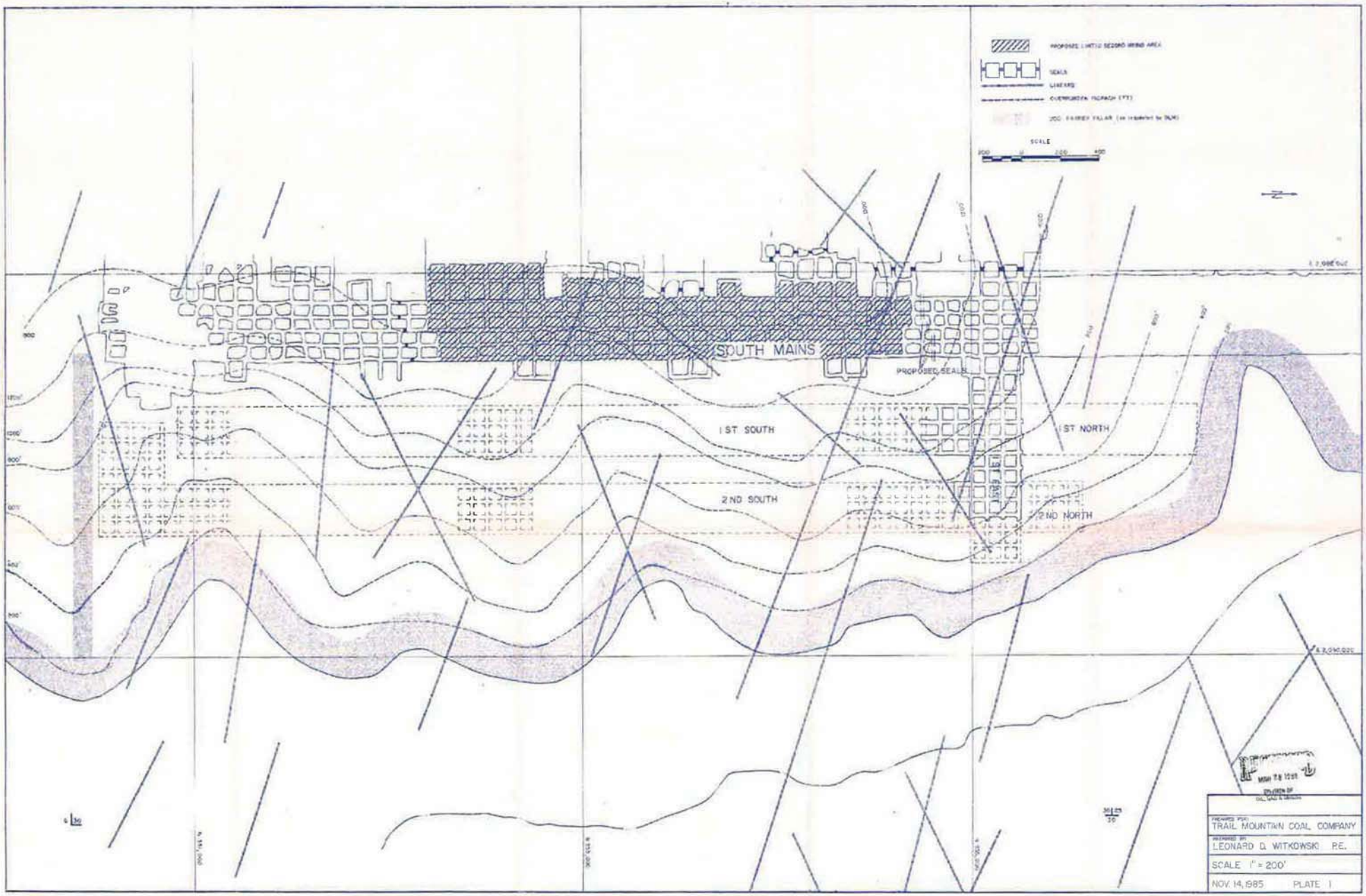
Wilson, A.H. and Ashwin, D.P., Research Into the Determination of Pillar Sizes, An Hypothesis Concerning Pillar Stability, Measurements of Stresses in Two Pillars at Lea Hall Colliery, Mining Engineering, Vol. 141, 1972, p. 409-430.

If I can be of further assistance or if you feel changes need to be made to this report please call me at 303-799-1045. As always it has been a pleasure working with you.

Sincerely,

Leonard Witkowski

PLATE I


SOUTH MAINS
PROPOSED SEALS
1ST SOUTH
1ST NORTH
2ND SOUTH
2ND NORTH
SCALE
TRAIL MOUNTAIN COAL COMPANY
LEONARD D. WITKOWSKI P.E.
SCALE 1" = 200'
NOV. 14, 1985 PLATE 1

Add to
Appendix 11-1

7/15/88

STATE OF UTAH
NATURAL RESOURCES
Oil, Gas & Mining

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
Dianne R. Nielson, Ph.D., Division Director

355 W. North Temple • 3 Triad Center • Suite 350 • Salt Lake City, UT 84180-1203 • 801-538-5340

March 2, 1988

Mr. Dan W. Guy, Manager
Permitting & Compliance
Beaver Creek Coal Company
P. O. Box 1378
Price, Utah 84501

Dear Mr. Guy:

Re: Final Approval of PAP Amendment, Second Mining East of Escarpment in Cottonwood Canyon, Beaver Creek Coal Company, Trail Mountain #9 Mine, ACT/015/009-88A, Folder No. 3, Carbon County, Utah

On February 22, 1988, the Division received Beaver Creek Coal Company's (BCCC) amended response to our deficiency review letter dated February 11, 1988. The supplemental information has been reviewed by Pamela Grubaugh-Littig, Reclamation Engineer, and Richard Smith, Geologist of the Division's technical staff. The operator's proposal has been determined technically adequate for approval. Please refer to the attached technical memorandum for an explanation of the technical review and approval recommendation. This letter will serve as the Division's final approval for this permit change application. Beaver Creek Company has now provided all of the information required by this office to finalize this permitting action.

The Division will forward extra copies of the approved plans to the appropriate state and federal agencies to update file copies of BCCC's approved Mining and Reclamation Plan (MRP). Thank you for your cooperation in completing this permitting action.

Sincerely,

D. Wayne Hedberg

D. Wayne Hedberg
Data Management Coordinator

djh
Attachment
cc: J. Dryden
R. Hagen
P. G.-Littig
8992R/36
G. Morris
P. Rutledge
J. Whitehead
P.F.O.

STATE OF UTAH
NATURAL RESOURCES
Oil, Gas & Mining

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
Dianne R. Nielson, Ph.D., Division Director

355 W. North Temple • 3 Triad Center • Suite 350 • Salt Lake City, UT 84180-1203 • 801-538-5340

March 1, 1988

TO: John Whitehead, Permit Supervisor

FROM: Pamela Grubaugh-Littig, Reclamation Engineer pgl
Rick Smith, Geologist RVS per pgl

RE: Amendment to Conduct Second Mining East of Escarpment in Cottonwood Canyon, Beaver Creek Coal Company, Trail Mountain #9 Mine, ACT/015/009-88A, Emery County, Utah

Materials dated January 28, 1988, Plate 1 submitted February 10, 1988, and the reply to deficiency letter submitted February 22, 1988, were all reviewed for the above-identified amendment.

Proposed second mining is delineated on Plate 3-6 and will occur in Section 36 (State Lease ML-22603), approximately 800 feet south of Section 25. Second mining will be conducted beyond outcropping Castlegate Sandstone.

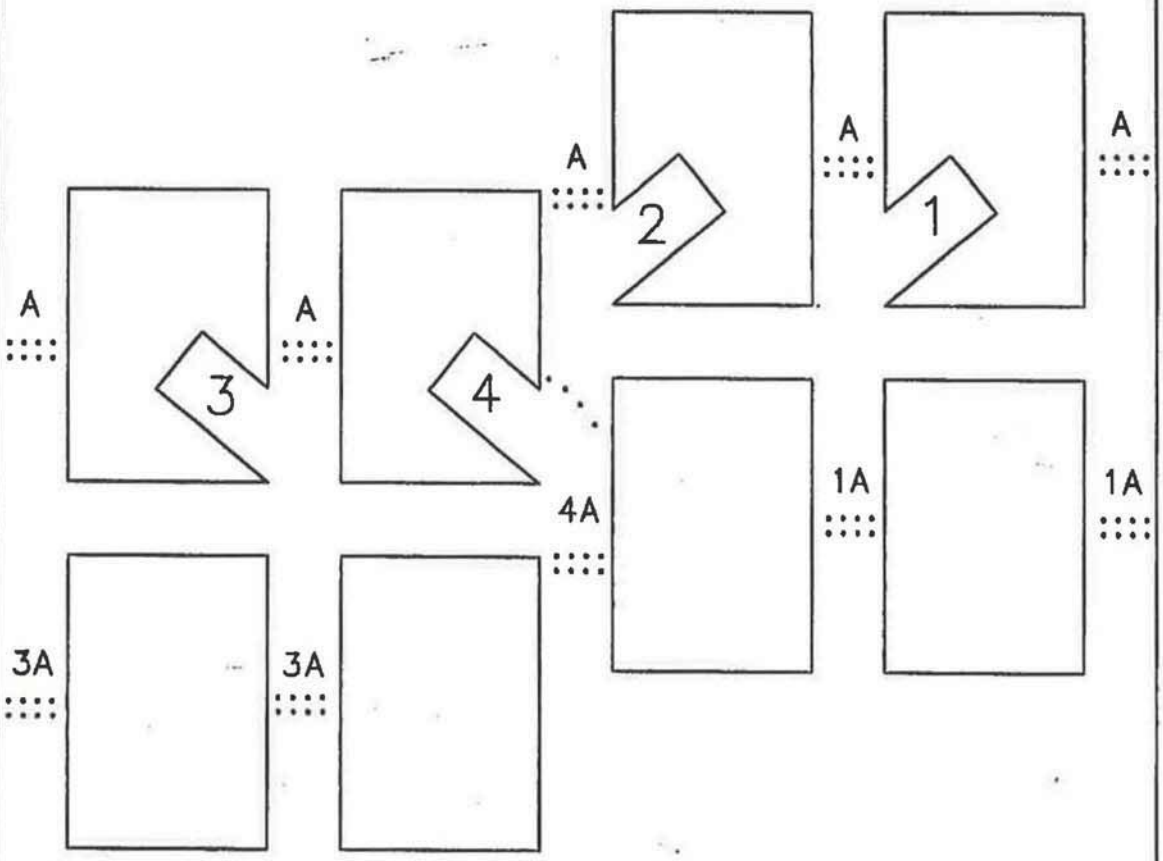
The overburden as shown on Plate 1 is from 1,200 to 1,300 feet thick above the proposed area of second mining. Room entries were originally driven on 80 foot centers and 60 x 60 foot square pillars were developed. Proposed second mining will result in either leaving 40 x 60 foot pillars or 47 x 60 foot pillars and maintenance of a minimum safety factor of 1.5 for the proposed pillar sizes at the given depths. Calculations (using three methodologies) indicate proposed pillars will be relatively stable and slowly crush over time.

The maximum extent of surface subsidence will be based on a 15 degree angle-of-draw, confined within a horizontal distance of 500 feet from the area of proposed second mining and will not affect USFS lands in Section 25.

Overburden thickness and the proposed development method suggest the area above second mining will be at relatively low risk for surface manifestations of subsidence (tension cracking, catastrophic failure) and accordingly, a relatively low risk is designated for potential impacts to renewable resource lands and other environmental resources.

It is herein recommended that the above-identified amendment be approved.

djh
9075R/53




PROPOSED

# TRAIL MOUNTAIN

# SOUTH MAIN PILLAR EXTRACTION SEQUENCE

(RIGHT TO LEFT)

WITH REMOTE CONTROL

NOTE: See Page 50 For Outline

| | | | |
|---|---|---|---|
| | BEAVER CREEK COAL | | |
| | *Main West Pillar Plan* | | |
| DWN | R.J.M. | Date | 15/Feb./88 |
| SCALE: 1"= 50' | | REV, Date | |
| ACAD DRAWING # | *Roof A: Page49* | | |

2/17/88

EXHIBIT 1

| OVERBURDEN DEPTH | ANGLE OF INTERNAL FRICTION | OVERBURDEN DENSITY | CONFINING STRESS | TAN B | MAXIMUM STABLE VERT STRESS | DISTANCE TO MAX VERT STRESS | RECT LOAD CARRY CAPACITY | DESIGN LOAD CAPACITY | DESIGN STRESS ALLOW | ACTUAL PILLAR STRESS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FEET | DEGREE | LB/FT3 | PSI | | PSI | FEET | TONS | TONS | PSI | PSI | |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 716740.7 | 477827.1 | 2765.2 | 3600.0 | 40x60 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 696516.1 | 464344.1 | 2687.2 | 3466.7 | |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 655887.2 | 437258.1 | 2530.4 | 3200.0 | |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 615004.0 | 410002.7 | 2372.7 | 2933.3 | |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 573846.7 | 382564.5 | 2213.9 | 2666.7 | |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 532392.3 | 354928.2 | 2054.0 | 2400.0 | |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 490613.4 | 327075.6 | 1892.8 | 2133.3 | |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 448477.6 | 298985.1 | 1730.2 | 1866.7 | |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 405945.5 | 270630.3 | 1566.1 | 1600.0 | — 600 |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 362968.2 | 241978.8 | 1400.3 | 1333.3 | |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 319483.5 | 212989.0 | 1232.6 | 1066.7 | |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 275409.8 | 183606.5 | 1062.5 | 800.0 | |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 230635.2 | 153756.8 | 889.8 | 533.3 | |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 184997.6 | 123331.7 | 713.7 | 266.7 | |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 138240.0 | 92160.0 | 533.3 | 0.0 | |
| 1350 | 30 | 144 | 4500 | 3.000 | 8547.41 | 1.2964 | 1398589.1 | 932392.7 | 5395.8 | 3600.0 | MAX |
| 1300 | 30 | 144 | 4500 | 3.000 | 8397.50 | 1.2606 | 1376148.8 | 917432.5 | 5309.2 | 3466.7 | |
| 1200 | 30 | 144 | 4500 | 3.000 | 8097.70 | 1.1872 | 1331160.8 | 887440.5 | 5135.7 | 3200.0 | |
| 1100 | 30 | 144 | 4500 | 3.000 | 7797.89 | 1.1109 | 1286025.1 | 857350.1 | 4961.5 | 2933.3 | |
| 1000 | 30 | 144 | 4500 | 3.000 | 7498.08 | 1.0317 | 1240735.7 | 827157.2 | 4786.8 | 2666.7 | |
| 900 | 30 | 144 | 4500 | 3.000 | 7198.27 | 0.9493 | 1195286.1 | 796857.4 | 4611.4 | 2400.0 | |
| 800 | 30 | 144 | 4500 | 3.000 | 6898.46 | 0.8633 | 1149669.1 | 766446.1 | 4435.5 | 2133.3 | |
| 700 | 30 | 144 | 4500 | 3.000 | 6598.66 | 0.7735 | 1103877.0 | 735918.0 | 4258.8 | 1866.7 | |
| 600 | 30 | 144 | 4500 | 3.000 | 6298.85 | 0.6795 | 1057901.5 | 705267.7 | 4081.4 | 1600.0 | |
| 500 | 30 | 144 | 4500 | 3.000 | 5999.04 | 0.5810 | 1011733.2 | 674488.8 | 3903.3 | 1333.3 | |
| 400 | 30 | 144 | 4500 | 3.000 | 5699.23 | 0.4774 | 965361.9 | 643574.6 | 3724.4 | 1066.7 | |
| 300 | 30 | 144 | 4500 | 3.000 | 5399.42 | 0.3682 | 918776.4 | 612517.6 | 3544.7 | 800.0 | |
| 200 | 30 | 144 | 4500 | 3.000 | 5099.62 | 0.2528 | 871964.0 | 581309.3 | 3364.1 | 533.3 | |
| 100 | 30 | 144 | 4500 | 3.000 | 4799.81 | 0.1303 | 824910.5 | 549940.3 | 3182.5 | 266.7 | |
| 0 | 30 | 144 | 4500 | 3.000 | 4500.00 | 0.0000 | 777600.0 | 518400.0 | 3000.0 | 0.0 | |
| 1350 | 32 | 144 | 800 | 3.255 | 5190.88 | 3.2184 | 781861.7 | 521241.1 | 3016.4 | 3600.0 | |
| 1300 | 32 | 144 | 800 | 3.255 | 5028.26 | 3.1636 | 759181.2 | 506120.8 | 2928.9 | 3466.7 | |
| 1200 | 32 | 144 | 800 | 3.255 | 4703.01 | 3.0485 | 713648.2 | 475765.4 | 2753.3 | 3200.0 | |
| 1100 | 32 | 144 | 800 | 3.255 | 4377.76 | 2.9252 | 667871.6 | 445247.7 | 2576.7 | 2933.3 | |
| 1000 | 32 | 144 | 800 | 3.255 | 4052.51 | 2.7923 | 621832.5 | 414555.0 | 2399.0 | 2666.7 | |
| 900 | 32 | 144 | 800 | 3.255 | 3727.25 | 2.6483 | 575508.5 | 383672.3 | 2220.3 | 2400.0 | |
| 800 | 32 | 144 | 800 | 3.255 | 3402.00 | 2.4912 | 528873.3 | 352582.2 | 2040.4 | 2133.3 | |
| 700 | 32 | 144 | 800 | 3.255 | 3076.75 | 2.3182 | 481895.5 | 321263.7 | 1859.2 | 1866.7 | 1832.9 ≈685 |
| 600 | 32 | 144 | 800 | 3.255 | 2751.50 | 2.1259 | 434536.9 | 289691.2 | 1676.5 | 1600.0 | |
| 500 | 32 | 144 | 800 | 3.255 | 2426.25 | 1.9094 | 386749.6 | 257833.1 | 1492.1 | 1333.3 | |
| 400 | 32 | 144 | 800 | 3.255 | 2101.00 | 1.6617 | 338472.7 | 225648.5 | 1305.8 | 1066.7 | |
| 300 | 32 | 144 | 800 | 3.255 | 1775.75 | 1.3723 | 289625.8 | 193083.9 | 1117.4 | 800.0 | |
| 200 | 32 | 144 | 800 | 3.255 | 1450.50 | 1.0241 | 240097.4 | 160065.0 | 926.3 | 533.3 | |
| 100 | 32 | 144 | 800 | 3.255 | 1125.25 | 0.5871 | 189723.8 | 126482.5 | 732.0 | 266.7 | |
| 0 | 32 | 144 | 800 | 3.255 | 800.00 | 0.0000 | 138240.0 | 92160.0 | 533.3 | 0.0 | |
| 1350 | 32 | 144 | 4500 | 3.255 | 8890.88 | 1.1719 | 1462497.1 | 974998.1 | 5642.3 | 3600.0 | |
| 1300 | 32 | 144 | 4500 | 3.255 | 8728.26 | 1.1401 | 1437681.2 | 958454.2 | 5546.6 | 3466.7 | |
| 1200 | 32 | 144 | 4500 | 3.255 | 8403.01 | 1.0748 | 1387944.8 | 925296.5 | 5354.7 | 3200.0 | |
| 1100 | 32 | 144 | 4500 | 3.255 | 8077.76 | 1.0069 | 1338064.0 | 892042.6 | 5162.3 | 2933.3 | |
| 1000 | 32 | 144 | 4500 | 3.255 | 7752.51 | 0.9361 | 1288032.6 | 858688.4 | 4969.3 | 2666.7 | |
| 900 | 32 | 144 | 4500 | 3.255 | 7427.25 | 0.8624 | 1237844.1 | 825229.4 | 4775.6 | 2400.0 | |
| 800 | 32 | 144 | 4500 | 3.255 | 7102.00 | 0.7853 | 1187491.2 | 791660.8 | 4581.4 | 2133.3 | |
| 700 | 32 | 144 | 4500 | 3.255 | 6776.75 | 0.7046 | 1136966.0 | 757977.3 | 4386.4 | 1866.7 | |
| 600 | 32 | 144 | 4500 | 3.255 | 6451.50 | 0.6200 | 1086259.8 | 724173.2 | 4190.8 | 1600.0 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 32 | 144 | 4500 | 3.255 | 6126.25 | 0.5309 | 1035363.0 | 690242.0 | 3994.5 | 1333.3 |
| 400 | 32 | 144 | 4500 | 3.255 | 5801.00 | 0.4371 | 984265.0 | 656176.6 | 3797.3 | 1066.7 |
| 300 | 32 | 144 | 4500 | 3.255 | 5475.75 | 0.3378 | 932953.9 | 621969.2 | 3599.4 | 800.0 |
| 200 | 32 | 144 | 4500 | 3.255 | 5150.50 | 0.2324 | 881416.4 | 587610.9 | 3400.5 | 533.3 |
| 100 | 32 | 144 | 4500 | 3.255 | 4825.25 | 0.1201 | 829637.5 | 553091.6 | 3200.8 | 266.7 |
| 0 | 32 | 144 | 4500 | 3.255 | 4500.00 | 0.0000 | 777600.0 | 518400.0 | 3000.0 | 0.0 |
| 1350 | 34 | 144 | 800 | 3.537 | 5572.07 | 2.8473 | 852959.7 | 568639.8 | 3290.7 | 3600.0 |
| 1300 | 34 | 144 | 800 | 3.537 | 5395.33 | 2.8000 | 827602.8 | 551735.2 | 3192.9 | 3466.7 |
| 1200 | 34 | 144 | 800 | 3.537 | 5041.84 | 2.7006 | 776724.6 | 517816.4 | 2996.6 | 3200.0 |
| 1100 | 34 | 144 | 800 | 3.537 | 4688.36 | 2.5940 | 725613.4 | 483742.3 | 2799.4 | 2933.3 |
| 1000 | 34 | 144 | 800 | 3.537 | 4334.87 | 2.4790 | 674250.9 | 449500.6 | 2601.3 | 2666.7 |
| 900 | 34 | 144 | 800 | 3.537 | 3981.38 | 2.3542 | 622615.7 | 415077.2 | 2402.1 | 2400.0 |
| 800 | 34 | 144 | 800 | 3.537 | 3627.89 | 2.2178 | 570682.4 | 380454.9 | 2201.7 | 2133.3 |
| 700 | 34 | 144 | 800 | 3.537 | 3274.41 | 2.0674 | 518420.5 | 345613.7 | 2000.1 | 1866.7 |
| 600 | 34 | 144 | 800 | 3.537 | 2920.92 | 1.8998 | 465792.7 | 310528.5 | 1797.0 | 1600.0 |
| 500 | 34 | 144 | 800 | 3.537 | 2567.43 | 1.7106 | 412752.6 | 275168.4 | 1592.4 | 1333.3 |
| 400 | 34 | 144 | 800 | 3.537 | 2213.95 | 1.4933 | 359240.4 | 239493.6 | 1386.0 | 1066.7 |
| 300 | 34 | 144 | 800 | 3.537 | 1860.46 | 1.2381 | 305176.6 | 203451.1 | 1177.4 | 800.0 |
| 200 | 34 | 144 | 800 | 3.537 | 1506.97 | 0.9290 | 250450.4 | 166966.9 | 966.2 | 533.3 |
| 100 | 34 | 144 | 800 | 3.537 | 1153.49 | 0.5368 | 194896.1 | 129930.7 | 751.9 | 266.7 |
| 0 | 34 | 144 | 800 | 3.537 | 800.00 | 0.0000 | 138240.0 | 92160.0 | 533.3 | 0.0 |
| 1350 | 34 | 144 | 4500 | 3.537 | 9272.07 | 1.0605 | 1532415.0 | ********* | 5912.1 | 3600.0 |
| 1300 | 34 | 144 | 4500 | 3.537 | 9095.33 | 1.0323 | 1505001.6 | ********* | 5806.3 | 3466.7 |
| 1200 | 34 | 144 | 4500 | 3.537 | 8741.84 | 0.9742 | 1450072.4 | 966715.0 | 5594.4 | 3200.0 |
| 1100 | 34 | 144 | 4500 | 3.537 | 8388.36 | 0.9136 | 1395002.1 | 930001.4 | 5382.0 | 2933.3 |
| 1000 | 34 | 144 | 4500 | 3.537 | 8034.87 | 0.8504 | 1339784.4 | 893189.6 | 5168.9 | 2666.7 |
| 900 | 34 | 144 | 4500 | 3.537 | 7681.38 | 0.7844 | 1284412.5 | 856275.0 | 4955.3 | 2400.0 |
| 800 | 34 | 144 | 4500 | 3.537 | 7327.89 | 0.7153 | 1228879.1 | 819252.7 | 4741.0 | 2133.3 |
| 700 | 34 | 144 | 4500 | 3.537 | 6974.41 | 0.6428 | 1173175.9 | 782117.3 | 4526.1 | 1866.7 |
| 600 | 34 | 144 | 4500 | 3.537 | 6620.92 | 0.5665 | 1117294.1 | 744862.7 | 4310.5 | 1600.0 |
| 500 | 34 | 144 | 4500 | 3.537 | 6267.43 | 0.4860 | 1061223.7 | 707482.5 | 4094.2 | 1333.3 |
| 400 | 34 | 144 | 4500 | 3.537 | 5913.95 | 0.4008 | 1004953.5 | 669969.0 | 3877.1 | 1066.7 |
| 300 | 34 | 144 | 4500 | 3.537 | 5560.46 | 0.3104 | 948471.2 | 632314.1 | 3659.2 | 800.0 |
| 200 | 34 | 144 | 4500 | 3.537 | 5206.97 | 0.2141 | 891762.6 | 594508.4 | 3440.4 | 533.3 |
| 100 | 34 | 144 | 4500 | 3.537 | 4853.49 | 0.1109 | 834811.6 | 556541.1 | 3220.7 | 266.7 |
| 0 | 34 | 144 | 4500 | 3.537 | 4500.00 | 0.0000 | 777600.0 | 518400.0 | 3000.0 | 0.0 |
| 1350 | 35 | 144 | 800 | 3.690 | 5778.54 | 2.6783 | 891078.1 | 594052.0 | 3437.8 | 3600.0 |
| 1300 | 35 | 144 | 800 | 3.690 | 5594.15 | 2.6344 | 864288.2 | 576192.1 | 3334.4 | 3466.7 |
| 1200 | 35 | 144 | 800 | 3.690 | 5225.37 | 2.5420 | 810547.6 | 540365.1 | 3127.1 | 3200.0 |
| 1100 | 35 | 144 | 800 | 3.690 | 4856.59 | 2.4429 | 756579.3 | 504386.2 | 2918.9 | 2933.3 |
| 1000 | 35 | 144 | 800 | 3.690 | 4487.81 | 2.3359 | 702365.4 | 468243.6 | 2709.7 | 2666.7 |
| 900 | 35 | 144 | 800 | 3.690 | 4119.03 | 2.2198 | 647884.7 | 431923.1 | 2499.6 | 2400.0 |
| 800 | 35 | 144 | 800 | 3.690 | 3750.25 | 2.0927 | 593112.2 | 395408.1 | 2288.2 | 2133.3 |
| 700 | 35 | 144 | 800 | 3.690 | 3381.47 | 1.9525 | 538018.0 | 358678.7 | 2075.7 | 1866.7 |
| 600 | 35 | 144 | 800 | 3.690 | 3012.69 | 1.7961 | 482565.4 | 321710.3 | 1861.7 | 1600.0 |
| 500 | 35 | 144 | 800 | 3.690 | 2643.91 | 1.6192 | 426708.5 | 284472.3 | 1646.3 | 1333.3 |
| 400 | 35 | 144 | 800 | 3.690 | 2275.12 | 1.4157 | 370388.1 | 246925.4 | 1429.0 | 1066.7 |
| 300 | 35 | 144 | 800 | 3.690 | 1906.34 | 1.1762 | 313525.2 | 209016.8 | 1209.6 | 800.0 |
| 200 | 35 | 144 | 800 | 3.690 | 1537.56 | 0.8850 | 256009.2 | 170672.8 | 987.7 | 533.3 |
| 100 | 35 | 144 | 800 | 3.690 | 1168.78 | 0.5135 | 197673.6 | 131782.4 | 762.6 | 266.7 |
| 0 | 35 | 144 | 800 | 3.690 | 800.00 | 0.0000 | 138240.0 | 92160.0 | 533.3 | 0.0 |
| 1350 | 35 | 144 | 4500 | 3.690 | 9478.54 | 1.0091 | 1569954.1 | ********* | 6056.9 | 3600.0 |
| 1300 | 35 | 144 | 4500 | 3.690 | 9294.15 | 0.9825 | 1541146.5 | ********* | 5945.8 | 3466.7 |
| 1200 | 35 | 144 | 4500 | 3.690 | 8925.37 | 0.9276 | 1483430.2 | 988953.4 | 5723.1 | 3200.0 |
| 1100 | 35 | 144 | 4500 | 3.690 | 8556.59 | 0.8705 | 1425574.2 | 950382.8 | 5499.9 | 2933.3 |
| 1000 | 35 | 144 | 4500 | 3.690 | 8187.81 | 0.8108 | 1367572.5 | 911715.0 | 5276.1 | 2666.7 |
| 900 | 35 | 144 | 4500 | 3.690 | 7819.03 | 0.7484 | 1309418.0 | 872945.3 | 5051.8 | 2400.0 |
| 800 | 35 | 144 | 4500 | 3.690 | 7450.25 | 0.6829 | 1251103.3 | 834068.9 | 4826.8 | 2133.3 |
| 700 | 35 | 144 | 4500 | 3.690 | 7081.47 | 0.6142 | 1192620.2 | 795080.1 | 4601.2 | 1866.7 |
| 600 | 35 | 144 | 4500 | 3.690 | 6712.69 | 0.5417 | 1133959.6 | 755973.0 | 4374.8 | 1600.0 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 35 | 144 | 4500 | 3.690 | 6343.91 | 0.4652 | 1075111.2 | 716740.8 | 4147.8 | 1333.3 |
| 400 | 35 | 144 | 4500 | 3.690 | 5975.12 | 0.3841 | 1016063.8 | 677375.9 | 3920.0 | 1066.7 |
| 300 | 35 | 144 | 4500 | 3.690 | 5606.34 | 0.2978 | 956804.6 | 637869.7 | 3691.4 | 800.0 |
| 200 | 35 | 144 | 4500 | 3.690 | 5237.56 | 0.2056 | 897319.0 | 598212.7 | 3461.9 | 533.3 |
| 100 | 35 | 144 | 4500 | 3.690 | 4868.78 | 0.1067 | 837590.6 | 558393.7 | 3231.4 | 266.7 |
| 0 | 35 | 144 | 4500 | 3.690 | 4500.00 | 0.0000 | 777600.0 | 518400.0 | 3000.0 | 0.0 |
| 1330 | 40 | 144 | 800 | 4.599 | 7004.55 | 1.9679 | 1113745.1 | 742496.7 | 4296.9 | 3600.0 |
| 1300 | 40 | 144 | 800 | 4.599 | 6774.76 | 1.9376 | 1078605.4 | 719070.3 | 4161.3 | 3466.7 |
| 1200 | 40 | 144 | 800 | 4.599 | 6315.16 | 1.8739 | 1008183.1 | 672122.1 | 3889.6 | 3200.0 |
| 1100 | 40 | 144 | 800 | 4.599 | 5855.56 | 1.8054 | 937558.5 | 625039.0 | 3617.1 | 2933.3 |
| 1000 | 40 | 144 | 800 | 4.599 | 5395.97 | 1.7312 | 866715.0 | 577810.0 | 3343.8 | 2666.7 |
| 900 | 40 | 144 | 800 | 4.599 | 4936.37 | 1.6505 | 795633.6 | 530422.4 | 3069.6 | 2400.0 |
| 800 | 40 | 144 | 800 | 4.599 | 4476.77 | 1.5619 | 724291.5 | 482861.0 | 2794.3 | 2133.3 |
| 700 | 40 | 144 | 800 | 4.599 | 4017.18 | 1.4636 | 652661.0 | 435107.3 | 2518.0 | 1866.7 |
| 600 | 40 | 144 | 800 | 4.599 | 3557.58 | 1.3534 | 580708.1 | 387138.7 | 2240.4 | 1600.0 |
| 500 | 40 | 144 | 800 | 4.599 | 3097.98 | 1.2280 | 508389.7 | 338926.5 | 1961.4 | 1333.3 |
| 400 | 40 | 144 | 800 | 4.599 | 2638.39 | 1.0823 | 435649.9 | 290433.2 | 1680.7 | 1066.7 |
| 300 | 40 | 144 | 800 | 4.599 | 2178.79 | 0.9087 | 362412.3 | 241608.2 | 1398.2 | 800.0 |
| 200 | 40 | 144 | 800 | 4.599 | 1719.19 | 0.6938 | 288567.6 | 192378.4 | 1113.3 | 533.3 |
| 100 | 40 | 144 | 800 | 4.599 | 1259.60 | 0.4117 | 213944.9 | 142630.0 | 825.4 | 266.7 |
| 0 | 40 | 144 | 800 | 4.599 | 800.00 | 0.0000 | 138240.0 | 92160.0 | 533.3 | 0.0 |
| 1350 | 40 | 144 | 4500 | 4.599 | 10704.55 | 0.7860 | 1789803.9 | ********* | 6905.1 | 3600.0 |
| 1300 | 40 | 144 | 4500 | 4.599 | 10474.76 | 0.7663 | 1752835.3 | ********* | 6762.5 | 3466.7 |
| 1200 | 40 | 144 | 4500 | 4.599 | 10015.16 | 0.7256 | 1678802.9 | ********* | 6476.9 | 3200.0 |
| 1100 | 40 | 144 | 4500 | 4.599 | 9555.56 | 0.6830 | 1604638.8 | ********* | 6190.7 | 2933.3 |
| 1000 | 40 | 144 | 4500 | 4.599 | 9095.97 | 0.6383 | 1530336.4 | ********* | 5904.1 | 2666.7 |
| 900 | 40 | 144 | 4500 | 4.599 | 8636.37 | 0.5913 | 1455888.5 | 970592.3 | 5616.9 | 2400.0 |
| 800 | 40 | 144 | 4500 | 4.599 | 8176.77 | 0.5417 | 1381287.2 | 920858.1 | 5329.0 | 2133.3 |
| 700 | 40 | 144 | 4500 | 4.599 | 7717.18 | 0.4892 | 1306523.6 | 871015.7 | 5040.6 | 1866.7 |
| 600 | 40 | 144 | 4500 | 4.599 | 7257.58 | 0.4335 | 1231587.9 | 821058.6 | 4751.5 | 1600.0 |
| 500 | 40 | 144 | 4500 | 4.599 | 6797.98 | 0.3742 | 1156468.7 | 770979.1 | 4461.7 | 1333.3 |
| 400 | 40 | 144 | 4500 | 4.599 | 6338.39 | 0.3107 | 1081153.4 | 720769.0 | 4171.1 | 1066.7 |
| 300 | 40 | 144 | 4500 | 4.599 | 5878.79 | 0.2424 | 1005627.4 | 670418.3 | 3879.7 | 800.0 |
| 200 | 40 | 144 | 4500 | 4.599 | 5419.19 | 0.1686 | 929873.7 | 619915.8 | 3587.5 | 533.3 |
| 100 | 40 | 144 | 4500 | 4.599 | 4959.60 | 0.0882 | 853872.4 | 569248.3 | 3294.3 | 266.7 |
| 0 | 40 | 144 | 4500 | 4.599 | 4500.00 | 0.0000 | 777600.0 | 518400.0 | 3000.0 | 0.0 |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 815091.8 | 543394.5 | 2795.2 | 3200.0 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 791933.1 | 527955.4 | 2715.8 | 3081.5 |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 745425.4 | 496950.2 | 2556.3 | 2844.4 |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 698648.5 | 465765.7 | 2395.9 | 2607.4 |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 651581.6 | 434387.7 | 2234.5 | 2370.4 |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 604200.2 | 402800.1 | 2072.0 | 2133.3 |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 556475.7 | 370983.8 | 1908.4 | 1896.3 |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 508373.9 | 338915.9 | 1743.4 | 1659.3 |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 459853.1 | 306568.8 | 1577.0 | 1422.2 |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 410861.9 | 273908.0 | 1409.0 | 1185.2 |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 361334.8 | 240889.9 | 1239.1 | 948.1 |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 311185.9 | 207457.3 | 1067.2 | 711.1 |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 260297.4 | 173531.6 | 892.7 | 474.1 |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 208498.8 | 138999.2 | 715.0 | 237.0 |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 155520.0 | 103680.0 | 533.3 | 0.0 |
| 1350 | 30 | 144 | 4500 | 3.000 | 8547.41 | 1.2964 | 1579224.0 | ********* | 5415.7 | 3200.0 |
| 1300 | 30 | 144 | 4500 | 3.000 | 8397.50 | 1.2606 | 1553723.8 | ********* | 5328.3 | 3081.5 |
| 1200 | 30 | 144 | 4500 | 3.000 | 8097.70 | 1.1872 | 1502610.2 | ********* | 5153.0 | 2844.4 |
| 1100 | 30 | 144 | 4500 | 3.000 | 7797.89 | 1.1109 | 1451340.8 | 967560.6 | 4977.2 | 2607.4 |
| 1000 | 30 | 144 | 4500 | 3.000 | 7498.08 | 1.0317 | 1399909.3 | 933272.9 | 4800.8 | 2370.4 |
| 900 | 30 | 144 | 4500 | 3.000 | 7198.27 | 0.9493 | 1348308.9 | 898872.6 | 4623.8 | 2133.3 |
| 800 | 30 | 144 | 4500 | 3.000 | 6898.46 | 0.8633 | 1296531.9 | 864354.6 | 4446.3 | 1896.3 |
| 700 | 30 | 144 | 4500 | 3.000 | 6598.66 | 0.7735 | 1244570.5 | 829713.7 | 4268.1 | 1659.3 |
| 600 | 30 | 144 | 4500 | 3.000 | 6298.85 | 0.6795 | 1192415.7 | 794943.8 | 4089.2 | 1422.2 |

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40×60

45×60

→ 200

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|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 30 | 144 | 4500 | 3.000 | 5999.04 | 0.5810 | 1140057.7 | 760038.5 | 3909.7 | 1185.2 |
| 400 | 30 | 144 | 4500 | 3.000 | 5699.23 | 0.4774 | 1087485.8 | 724990.6 | 3729.4 | 948.1 |
| 300 | 30 | 144 | 4500 | 3.000 | 5399.42 | 0.3682 | 1034688.2 | 689792.2 | 3548.3 | 711.1 |
| 200 | 30 | 144 | 4500 | 3.000 | 5099.62 | 0.2528 | 981651.6 | 654434.4 | 3366.4 | 474.1 |
| 100 | 30 | 144 | 4500 | 3.000 | 4799.81 | 0.1303 | 928361.1 | 618907.4 | 3183.7 | 237.0 |
| 0 | 30 | 144 | 4500 | 3.000 | 4500.00 | 0.0000 | 874800.0 | 583200.0 | 3000.0 | 0.0 |
| 1350 | 32 | 144 | 800 | 3.255 | 5190.88 | 3.2184 | 887970.6 | 591980.4 | 3043.2 | 3200.0 |
| 1300 | 32 | 144 | 800 | 3.255 | 5028.26 | 3.1636 | 862064.9 | 574710.0 | 2956.3 | 3081.5 |
| 1200 | 32 | 144 | 800 | 3.255 | 4703.01 | 3.0485 | 810071.7 | 540047.8 | 2778.0 | 2844.4 |
| 1100 | 32 | 144 | 800 | 3.255 | 4377.76 | 2.9252 | 757821.1 | 505214.1 | 2598.8 | 2607.4 |
| 1000 | 32 | 144 | 800 | 3.255 | 4052.51 | 2.7923 | 705292.9 | 470195.3 | 2418.7 | 2370.4 |
| 900 | 32 | 144 | 800 | 3.255 | 3727.25 | 2.6483 | 652463.6 | 434975.7 | 2237.5 | 2133.3 |
| 800 | 32 | 144 | 800 | 3.255 | 3402.00 | 2.4912 | 599305.6 | 399537.1 | 2055.2 | 1896.3 |
| 700 | 32 | 144 | 800 | 3.255 | 3076.75 | 2.3182 | 545785.7 | 363857.1 | 1871.7 | 1659.3 |
| 600 | 32 | 144 | 800 | 3.255 | 2751.50 | 2.1259 | 491863.5 | 327909.0 | 1686.8 | 1422.2 |
| 500 | 32 | 144 | 800 | 3.255 | 2426.25 | 1.9094 | 437488.8 | 291659.2 | 1500.3 | 1185.2 |
| 400 | 32 | 144 | 800 | 3.255 | 2101.00 | 1.6617 | 382597.5 | 255065.0 | 1312.1 | 948.1 |
| 300 | 32 | 144 | 800 | 3.255 | 1775.75 | 1.3723 | 327104.8 | 218069.9 | 1121.8 | 711.1 |
| 200 | 32 | 144 | 800 | 3.255 | 1450.50 | 1.0241 | 270893.5 | 180595.7 | 929.0 | 474.1 |
| 100 | 32 | 144 | 800 | 3.255 | 1125.25 | 0.5871 | 213791.4 | 142527.6 | 733.2 | 237.0 |
| 0 | 32 | 144 | 800 | 3.255 | 800.00 | 0.0000 | 155520.0 | 103680.0 | 533.3 | 0.0 |
| 1350 | 32 | 144 | 4500 | 3.255 | 8890.88 | 1.1719 | 1650789.2 | ********* | 5661.1 | 3200.0 |
| 1300 | 32 | 144 | 4500 | 3.255 | 8728.26 | 1.1401 | 1622629.1 | ********* | 5564.6 | 3081.5 |
| 1200 | 32 | 144 | 4500 | 3.255 | 8403.01 | 1.0748 | 1566198.4 | ********* | 5371.1 | 2844.4 |
| 1100 | 32 | 144 | 4500 | 3.255 | 8077.76 | 1.0069 | 1509615.6 | ********* | 5177.0 | 2607.4 |
| 1000 | 32 | 144 | 4500 | 3.255 | 7752.51 | 0.9361 | 1452874.1 | 968582.7 | 4982.4 | 2370.4 |
| 900 | 32 | 144 | 4500 | 3.255 | 7427.25 | 0.8624 | 1395967.0 | 930644.7 | 4787.3 | 2133.3 |
| 800 | 32 | 144 | 4500 | 3.255 | 7102.00 | 0.7853 | 1338886.7 | 892591.1 | 4591.5 | 1896.3 |
| 700 | 32 | 144 | 4500 | 3.255 | 6776.75 | 0.7046 | 1281624.8 | 854416.6 | 4395.1 | 1659.3 |
| 600 | 32 | 144 | 4500 | 3.255 | 6451.50 | 0.6200 | 1224172.3 | 816114.9 | 4198.1 | 1422.2 |
| 500 | 32 | 144 | 4500 | 3.255 | 6126.25 | 0.5309 | 1166519.1 | 777679.4 | 4000.4 | 1185.2 |
| 400 | 32 | 144 | 4500 | 3.255 | 5801.00 | 0.4371 | 1108653.9 | 739102.6 | 3802.0 | 948.1 |
| 300 | 32 | 144 | 4500 | 3.255 | 5475.75 | 0.3378 | 1050564.3 | 700376.2 | 3602.8 | 711.1 |
| 200 | 32 | 144 | 4500 | 3.255 | 5150.50 | 0.2324 | 992236.3 | 661490.9 | 3402.7 | 474.1 |
| 100 | 32 | 144 | 4500 | 3.255 | 4825.25 | 0.1201 | 933654.2 | 622436.2 | 3201.8 | 237.0 |
| 0 | 32 | 144 | 4500 | 3.255 | 4500.00 | 0.0000 | 874800.0 | 583200.0 | 3000.0 | 0.0 |
| 1350 | 34 | 144 | 800 | 3.537 | 5572.07 | 2.8473 | 967604.9 | 645070.0 | 3318.3 | 3200.0 |
| 1300 | 34 | 144 | 800 | 3.537 | 5395.33 | 2.8000 | 938703.4 | 625802.3 | 3219.1 | 3081.5 |
| 1200 | 34 | 144 | 800 | 3.537 | 5041.84 | 2.7006 | 880726.6 | 587151.0 | 3020.3 | 2844.4 |
| 1100 | 34 | 144 | 800 | 3.537 | 4688.36 | 2.5940 | 822503.7 | 548335.8 | 2820.7 | 2607.4 |
| 1000 | 34 | 144 | 800 | 3.537 | 4334.87 | 2.4790 | 764015.5 | 509343.7 | 2620.1 | 2370.4 |
| 900 | 34 | 144 | 800 | 3.537 | 3981.38 | 2.3542 | 705239.3 | 470159.5 | 2418.5 | 2133.3 |
| 800 | 34 | 144 | 800 | 3.537 | 3627.89 | 2.2178 | 646148.4 | 430765.6 | 2215.9 | 1896.3 |
| 700 | 34 | 144 | 800 | 3.537 | 3274.41 | 2.0674 | 586710.7 | 391140.4 | 2012.0 | 1659.3 |
| 600 | 34 | 144 | 800 | 3.537 | 2920.92 | 1.8998 | 526886.9 | 351257.9 | 1806.9 | 1422.2 |
| 500 | 34 | 144 | 800 | 3.537 | 2567.43 | 1.7106 | 466628.1 | 311085.4 | 1600.2 | 1185.2 |
| 400 | 34 | 144 | 800 | 3.537 | 2213.95 | 1.4933 | 405871.5 | 270581.0 | 1391.9 | 948.1 |
| 300 | 34 | 144 | 800 | 3.537 | 1860.46 | 1.2381 | 344533.3 | 229688.9 | 1181.5 | 711.1 |
| 200 | 34 | 144 | 800 | 3.537 | 1506.97 | 0.9290 | 282497.0 | 188331.3 | 968.8 | 474.1 |
| 100 | 34 | 144 | 800 | 3.537 | 1153.49 | 0.5368 | 219588.5 | 146392.3 | 753.0 | 237.0 |
| 0 | 34 | 144 | 800 | 3.537 | 800.00 | 0.0000 | 155520.0 | 103680.0 | 533.3 | 0.0 |
| 1350 | 34 | 144 | 4500 | 3.537 | 9272.07 | 1.0605 | 1729151.8 | ********* | 5929.9 | 3200.0 |
| 1300 | 34 | 144 | 4500 | 3.537 | 9095.33 | 1.0323 | 1698080.6 | ********* | 5823.3 | 3081.5 |
| 1200 | 34 | 144 | 4500 | 3.537 | 8741.84 | 0.9742 | 1635830.5 | ********* | 5609.8 | 2844.4 |
| 1100 | 34 | 144 | 4500 | 3.537 | 8388.36 | 0.9136 | 1573431.7 | ********* | 5395.9 | 2607.4 |
| 1000 | 34 | 144 | 4500 | 3.537 | 8034.87 | 0.8504 | 1510877.6 | ********* | 5181.3 | 2370.4 |
| 900 | 34 | 144 | 4500 | 3.537 | 7681.38 | 0.7844 | 1448161.2 | 965440.8 | 4966.3 | 2133.3 |
| 800 | 34 | 144 | 4500 | 3.537 | 7327.89 | 0.7153 | 1385274.5 | 923516.4 | 4750.6 | 1896.3 |
| 700 | 34 | 144 | 4500 | 3.537 | 6974.41 | 0.6428 | 1322209.2 | 881472.8 | 4534.3 | 1659.3 |
| 600 | 34 | 144 | 4500 | 3.537 | 6620.92 | 0.5665 | 1258955.8 | 839303.8 | 4317.4 | 1422.2 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 34 | 144 | 4500 | 3.537 | 6267.43 | 0.4860 | 1195503.7 | 797002.5 | 4099.8 | 1185.2 |
| 400 | 34 | 144 | 4500 | 3.537 | 5913.95 | 0.4008 | 1131841.4 | 754560.9 | 3881.5 | 948.1 |
| 300 | 34 | 144 | 4500 | 3.537 | 5560.46 | 0.3104 | 1067955.7 | 711970.5 | 3662.4 | 711.1 |
| 200 | 34 | 144 | 4500 | 3.537 | 5206.97 | 0.2141 | 1003831.9 | 669221.3 | 3442.5 | 474.1 |
| 100 | 34 | 144 | 4500 | 3.537 | 4853.49 | 0.1109 | 939453.1 | 626302.1 | 3221.7 | 237.0 |
| 0 | 34 | 144 | 4500 | 3.537 | 4500.00 | 0.0000 | 874800.0 | 583200.0 | 3000.0 | 0.0 |
| 1350 | 35 | 144 | 800 | 3.690 | 5778.54 | 2.6783 | 1010322.9 | 673548.6 | 3464.8 | 3200.0 |
| 1300 | 35 | 144 | 800 | 3.690 | 5594.15 | 2.6344 | 979816.5 | 653211.0 | 3360.1 | 3081.5 |
| 1200 | 35 | 144 | 800 | 3.690 | 5225.37 | 2.5420 | 918633.7 | 612422.5 | 3150.3 | 2844.4 |
| 1100 | 35 | 144 | 800 | 3.690 | 4856.59 | 2.4429 | 857210.6 | 571473.7 | 2939.7 | 2607.4 |
| 1000 | 35 | 144 | 800 | 3.690 | 4487.81 | 2.3359 | 795528.1 | 530352.1 | 2728.1 | 2370.4 |
| 900 | 35 | 144 | 800 | 3.690 | 4119.03 | 2.2198 | 733564.1 | 489042.7 | 2515.7 | 2133.3 |
| 800 | 35 | 144 | 800 | 3.690 | 3750.25 | 2.0927 | 671292.2 | 447528.1 | 2302.1 | 1896.3 |
| 700 | 35 | 144 | 800 | 3.690 | 3381.47 | 1.9525 | 608680.9 | 405787.2 | 2087.4 | 1659.3 |
| 600 | 35 | 144 | 800 | 3.690 | 3012.69 | 1.7961 | 545691.5 | 363794.3 | 1871.4 | 1422.2 |
| 500 | 35 | 144 | 800 | 3.690 | 2643.91 | 1.6192 | 482275.7 | 321517.1 | 1653.9 | 1185.2 |
| 400 | 35 | 144 | 800 | 3.690 | 2275.12 | 1.4157 | 418371.2 | 278914.1 | 1434.7 | 948.1 |
| 300 | 35 | 144 | 800 | 3.690 | 1906.34 | 1.1762 | 353895.0 | 235930.0 | 1213.6 | 711.1 |
| 200 | 35 | 144 | 800 | 3.690 | 1537.56 | 0.8850 | 288730.7 | 192487.1 | 990.2 | 474.1 |
| 100 | 35 | 144 | 800 | 3.690 | 1168.78 | 0.5135 | 222703.2 | 148468.8 | 763.7 | 237.0 |
| 0 | 35 | 144 | 800 | 3.690 | 800.00 | 0.0000 | 155520.0 | 103680.0 | 533.3 | 0.0 |
| 1350 | 35 | 144 | 4500 | 3.690 | 9478.54 | 1.0091 | 1771247.4 | ********* | 6074.2 | 3200.0 |
| 1300 | 35 | 144 | 4500 | 3.690 | 9294.15 | 0.9825 | 1738613.0 | ********* | 5962.3 | 3081.5 |
| 1200 | 35 | 144 | 4500 | 3.690 | 8925.37 | 0.9276 | 1673237.6 | ********* | 5738.1 | 2844.4 |
| 1100 | 35 | 144 | 4500 | 3.690 | 8556.59 | 0.8705 | 1607715.3 | ********* | 5513.4 | 2607.4 |
| 1000 | 35 | 144 | 4500 | 3.690 | 8187.81 | 0.8108 | 1542039.3 | ********* | 5288.2 | 2370.4 |
| 900 | 35 | 144 | 4500 | 3.690 | 7819.03 | 0.7484 | 1476202.5 | 984135.0 | 5062.4 | 2133.3 |
| 800 | 35 | 144 | 4500 | 3.690 | 7450.25 | 0.6829 | 1410197.0 | 940131.3 | 4836.1 | 1896.3 |
| 700 | 35 | 144 | 4500 | 3.690 | 7081.47 | 0.6142 | 1344014.2 | 896009.5 | 4609.1 | 1659.3 |
| 600 | 35 | 144 | 4500 | 3.690 | 6712.69 | 0.5417 | 1277644.5 | 851763.0 | 4381.5 | 1422.2 |
| 500 | 35 | 144 | 4500 | 3.690 | 6343.91 | 0.4652 | 1211077.2 | 807384.8 | 4153.2 | 1185.2 |
| 400 | 35 | 144 | 4500 | 3.690 | 5975.12 | 0.3841 | 1144300.4 | 762866.9 | 3924.2 | 948.1 |
| 300 | 35 | 144 | 4500 | 3.690 | 5606.34 | 0.2978 | 1077300.6 | 718200.4 | 3694.4 | 711.1 |
| 200 | 35 | 144 | 4500 | 3.690 | 5237.56 | 0.2056 | 1010062.7 | 673375.2 | 3463.9 | 474.1 |
| 100 | 35 | 144 | 4500 | 3.690 | 4868.78 | 0.1067 | 942569.2 | 628379.5 | 3232.4 | 237.0 |
| 0 | 35 | 144 | 4500 | 3.690 | 4500.00 | 0.0000 | 874800.0 | 583200.0 | 3000.0 | 0.0 |
| 1350 | 40 | 144 | 800 | 4.599 | 7004.55 | 1.9679 | 1260081.2 | 840054.1 | 4321.3 | 3200.0 |
| 1300 | 40 | 144 | 800 | 4.599 | 6774.76 | 1.9376 | 1220214.4 | 813476.3 | 4184.5 | 3081.5 |
| 1200 | 40 | 144 | 800 | 4.599 | 6315.16 | 1.8739 | 1140330.3 | 760220.2 | 3910.6 | 2844.4 |
| 1100 | 40 | 144 | 800 | 4.599 | 5855.56 | 1.8054 | 1060232.9 | 706821.9 | 3635.9 | 2607.4 |
| 1000 | 40 | 144 | 800 | 4.599 | 5395.97 | 1.7312 | 979904.9 | 653269.9 | 3360.4 | 2370.4 |
| 900 | 40 | 144 | 800 | 4.599 | 4936.37 | 1.6505 | 899326.1 | 599550.8 | 3084.1 | 2133.3 |
| 800 | 40 | 144 | 800 | 4.599 | 4476.77 | 1.5619 | 818472.6 | 545648.4 | 2806.8 | 1896.3 |
| 700 | 40 | 144 | 800 | 4.599 | 4017.18 | 1.4636 | 737315.3 | 491543.5 | 2528.5 | 1659.3 |
| 600 | 40 | 144 | 800 | 4.599 | 3557.58 | 1.3534 | 655818.4 | 437212.3 | 2249.0 | 1422.2 |
| 500 | 40 | 144 | 800 | 4.599 | 3097.98 | 1.2280 | 573936.6 | 382624.4 | 1968.2 | 1185.2 |
| 400 | 40 | 144 | 800 | 4.599 | 2638.39 | 1.0823 | 491611.0 | 327740.7 | 1685.9 | 948.1 |
| 300 | 40 | 144 | 800 | 4.599 | 2178.79 | 0.9087 | 408761.4 | 272507.6 | 1401.8 | 711.1 |
| 200 | 40 | 144 | 800 | 4.599 | 1719.19 | 0.6938 | 325272.7 | 216848.5 | 1115.5 | 474.1 |
| 100 | 40 | 144 | 800 | 4.599 | 1259.60 | 0.4117 | 240965.5 | 160643.7 | 826.4 | 237.0 |
| 0 | 40 | 144 | 800 | 4.599 | 800.00 | 0.0000 | 155520.0 | 103680.0 | 533.3 | 0.0 |
| 1350 | 40 | 144 | 4500 | 4.599 | 10704.55 | 0.7860 | 2017993.4 | ********* | 6920.4 | 3200.0 |
| 1300 | 40 | 144 | 4500 | 4.599 | 10474.76 | 0.7663 | 1976200.3 | ********* | 6777.1 | 3081.5 |
| 1200 | 40 | 144 | 4500 | 4.599 | 10015.16 | 0.7256 | 1892514.2 | ********* | 6490.1 | 2844.4 |
| 1100 | 40 | 144 | 4500 | 4.599 | 9555.56 | 0.6830 | 1808689.4 | ********* | 6202.6 | 2607.4 |
| 1000 | 40 | 144 | 4500 | 4.599 | 9095.97 | 0.6383 | 1724719.1 | ********* | 5914.7 | 2370.4 |
| 900 | 40 | 144 | 4500 | 4.599 | 8636.37 | 0.5913 | 1640595.8 | ********* | 5626.2 | 2133.3 |
| 800 | 40 | 144 | 4500 | 4.599 | 8176.77 | 0.5417 | 1556311.0 | ********* | 5337.1 | 1896.3 |
| 700 | 40 | 144 | 4500 | 4.599 | 7717.18 | 0.4892 | 1471855.5 | 981237.0 | 5047.5 | 1659.3 |
| 600 | 40 | 144 | 4500 | 4.599 | 7257.58 | 0.4335 | 1387218.9 | 924812.6 | 4757.3 | 1422.2 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 40 | 144 | 4500 | 4.599 | 6797.98 | 0.3742 | 1302389.4 | 868259.6 | 4466.4 | 1185.2 | |
| 400 | 40 | 144 | 4500 | 4.599 | 6338.39 | 0.3107 | 1217353.7 | 811569.1 | 4174.7 | 948.1 | |
| 300 | 40 | 144 | 4500 | 4.599 | 5878.79 | 0.2424 | 1132096.2 | 754730.8 | 3882.4 | 711.1 | |
| 200 | 40 | 144 | 4500 | 4.599 | 5419.19 | 0.1686 | 1046599.4 | 697732.9 | 3589.2 | 474.1 | |
| 100 | 40 | 144 | 4500 | 4.599 | 4959.60 | 0.0882 | 960842.2 | 640561.5 | 3295.1 | 237.0 | |
| 0 | 40 | 144 | 4500 | 4.599 | 4500.00 | 0.0000 | 874800.0 | 583200.0 | 3000.0 | 0.0 | 45×60 |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 854432.2 | 569621.5 | 2805.5 | 3063.8 | 47×60 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 830099.9 | 553399.9 | 2725.6 | 2950.4 | |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 781240.6 | 520827.1 | 2565.1 | 2723.4 | |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 732106.3 | 488070.9 | 2403.8 | 2496.5 | |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 682675.5 | 455117.0 | 2241.5 | 2269.5 | |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 632923.4 | 421948.9 | 2078.2 | 2042.6 | — 900 |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 582820.7 | 388547.1 | 1913.6 | 1815.6 | |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 532332.4 | 354888.3 | 1747.9 | 1588.7 | |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 481416.2 | 320944.1 | 1580.7 | 1361.7 | |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 430019.4 | 286679.6 | 1411.9 | 1134.8 | |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 378075.4 | 252050.3 | 1241.4 | 907.8 | |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 325496.3 | 216997.6 | 1068.7 | 680.9 | |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 272162.3 | 181441.6 | 893.6 | 453.9 | |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 217899.3 | 145266.2 | 715.5 | 227.0 | |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 162432.0 | 108288.0 | 533.3 | 0.0 | |
| 1350 | 30 | 144 | 4500 | 3.000 | 8547.41 | 1.2964 | 1651478.0 | ********* | 5422.5 | 3063.8 | MAX |
| 1300 | 30 | 144 | 4500 | 3.000 | 8397.50 | 1.2606 | 1624753.8 | ********* | 5334.8 | 2950.4 | |
| 1200 | 30 | 144 | 4500 | 3.000 | 8097.70 | 1.1872 | 1571190.0 | ********* | 5158.9 | 2723.4 | |
| 1100 | 30 | 144 | 4500 | 3.000 | 7797.89 | 1.1109 | 1517467.1 | ********* | 4982.5 | 2496.5 | |
| 1000 | 30 | 144 | 4500 | 3.000 | 7498.08 | 1.0317 | 1463578.8 | 975719.2 | 4805.6 | 2269.5 | |
| 900 | 30 | 144 | 4500 | 3.000 | 7198.27 | 0.9493 | 1409518.0 | 939678.6 | 4628.0 | 2042.6 | |
| 800 | 30 | 144 | 4500 | 3.000 | 6898.46 | 0.8633 | 1355277.1 | 903518.1 | 4450.0 | 1815.6 | |
| 700 | 30 | 144 | 4500 | 3.000 | 6598.66 | 0.7735 | 1300847.9 | 867231.9 | 4271.2 | 1588.7 | |
| 600 | 30 | 144 | 4500 | 3.000 | 6298.85 | 0.6795 | 1246221.3 | 830814.2 | 4091.9 | 1361.7 | |
| 500 | 30 | 144 | 4500 | 3.000 | 5999.04 | 0.5810 | 1191387.5 | 794258.3 | 3911.8 | 1134.8 | |
| 400 | 30 | 144 | 4500 | 3.000 | 5699.23 | 0.4774 | 1136335.4 | 757556.9 | 3731.1 | 907.8 | |
| 300 | 30 | 144 | 4500 | 3.000 | 5399.42 | 0.3682 | 1081053.0 | 720702.0 | 3549.6 | 680.9 | |
| 200 | 30 | 144 | 4500 | 3.000 | 5099.62 | 0.2528 | 1025526.7 | 683684.5 | 3367.2 | 453.9 | |
| 100 | 30 | 144 | 4500 | 3.000 | 4799.81 | 0.1303 | 969741.4 | 646494.3 | 3184.1 | 227.0 | |
| 0 | 30 | 144 | 4500 | 3.000 | 4500.00 | 0.0000 | 913680.0 | 609120.0 | 3000.0 | 0.0 | |
| 1350 | 32 | 144 | 800 | 3.255 | 5190.88 | 3.2184 | 930414.1 | 620276.1 | 3054.9 | 3063.8 | -1022 1332 |
| 1300 | 32 | 144 | 800 | 3.255 | 5028.26 | 3.1636 | 903218.4 | 602145.6 | 2965.7 | 2950.4 | |
| 1200 | 32 | 144 | 800 | 3.255 | 4703.01 | 3.0485 | 848641.2 | 565760.8 | 2786.4 | 2723.4 | |
| 1100 | 32 | 144 | 800 | 3.255 | 4377.76 | 2.9252 | 793800.9 | 529200.6 | 2606.4 | 2496.5 | |
| 1000 | 32 | 144 | 800 | 3.255 | 4052.51 | 2.7923 | 738677.1 | 492451.4 | 2425.4 | 2269.5 | |
| 900 | 32 | 144 | 800 | 3.255 | 3727.25 | 2.6483 | 683245.7 | 455497.1 | 2243.4 | 2042.6 | |
| 800 | 32 | 144 | 800 | 3.255 | 3402.00 | 2.4912 | 627478.5 | 418319.0 | 2060.3 | 1815.6 | |
| 700 | 32 | 144 | 800 | 3.255 | 3076.75 | 2.3182 | 571341.7 | 380894.5 | 1876.0 | 1588.7 | |
| 600 | 32 | 144 | 800 | 3.255 | 2751.50 | 2.1259 | 514794.2 | 343196.1 | 1690.3 | 1361.7 | |
| 500 | 32 | 144 | 800 | 3.255 | 2426.25 | 1.9094 | 457784.5 | 305189.7 | 1503.1 | 1134.8 | |
| 400 | 32 | 144 | 800 | 3.255 | 2101.00 | 1.6617 | 400247.4 | 266831.6 | 1314.2 | 907.8 | |
| 300 | 32 | 144 | 800 | 3.255 | 1775.75 | 1.3723 | 342096.4 | 228064.2 | 1123.2 | 680.9 | |
| 200 | 32 | 144 | 800 | 3.255 | 1450.50 | 1.0241 | 283211.9 | 188807.9 | 929.9 | 453.9 | |
| 100 | 32 | 144 | 800 | 3.255 | 1125.25 | 0.5871 | 223418.4 | 148945.6 | 733.6 | 227.0 | |
| 0 | 32 | 144 | 800 | 3.255 | 800.00 | 0.0000 | 162432.0 | 108288.0 | 533.3 | 0.0 | |
| 1350 | 32 | 144 | 4500 | 3.255 | 8890.88 | 1.1719 | 1726106.0 | ********* | 5667.5 | 3063.8 | |
| 1300 | 32 | 144 | 4500 | 3.255 | 8728.26 | 1.1401 | 1696608.2 | ********* | 5570.7 | 2950.4 | |
| 1200 | 32 | 144 | 4500 | 3.255 | 8403.01 | 1.0748 | 1637499.9 | ********* | 5376.6 | 2723.4 | |
| 1100 | 32 | 144 | 4500 | 3.255 | 8077.76 | 1.0069 | 1578236.2 | ********* | 5182.0 | 2496.5 | |
| 1000 | 32 | 144 | 4500 | 3.255 | 7752.51 | 0.9361 | 1518810.7 | ********* | 4986.9 | 2269.5 | |
| 900 | 32 | 144 | 4500 | 3.255 | 7427.25 | 0.8624 | 1459216.2 | 972810.8 | 4791.2 | 2042.6 | |
| 800 | 32 | 144 | 4500 | 3.255 | 7102.00 | 0.7853 | 1399444.9 | 932963.3 | 4595.0 | 1815.6 | |
| 700 | 32 | 144 | 4500 | 3.255 | 6776.75 | 0.7046 | 1339488.4 | 892992.3 | 4398.1 | 1588.7 | |
| 600 | 32 | 144 | 4500 | 3.255 | 6451.50 | 0.6200 | 1279337.4 | 852891.6 | 4200.6 | 1361.7 | |

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|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 32 | 144 | 4500 | 3.255 | 6126.25 | 0.5309 | 1218981.5 | 812654.3 | 4002.4 | 1134.8 |
| 400 | 32 | 144 | 4500 | 3.255 | 5801.00 | 0.4371 | 1158409.4 | 772273.0 | 3803.6 | 907.8 |
| 300 | 32 | 144 | 4500 | 3.255 | 5475.75 | 0.3378 | 1097608.5 | 731739.0 | 3603.9 | 680.9 |
| 200 | 32 | 144 | 4500 | 3.255 | 5150.50 | 0.2324 | 1036564.3 | 691042.9 | 3403.5 | 453.9 |
| 100 | 32 | 144 | 4500 | 3.255 | 4825.25 | 0.1201 | 975261.0 | 650174.0 | 3202.2 | 227.0 |
| 0 | 32 | 144 | 4500 | 3.255 | 4500.00 | 0.0000 | 913680.0 | 609120.0 | 3000.0 | 0.0 |
| 1350 | 34 | 144 | 800 | 3.537 | 5572.07 | 2.8473 | 1013463.0 | 675642.0 | 3327.6 | 3063.8 |
| 1300 | 34 | 144 | 800 | 3.537 | 5395.33 | 2.8000 | 983143.6 | 655429.1 | 3228.1 | 2950.4 |
| 1200 | 34 | 144 | 800 | 3.537 | 5041.84 | 2.7006 | 922327.4 | 614884.9 | 3028.4 | 2723.4 |
| 1100 | 34 | 144 | 800 | 3.537 | 4688.36 | 2.5940 | 861259.8 | 574173.2 | 2827.9 | 2496.5 |
| 1000 | 34 | 144 | 800 | 3.537 | 4334.87 | 2.4790 | 799921.3 | 533280.9 | 2626.5 | 2269.5 |
| 900 | 34 | 144 | 800 | 3.537 | 3981.38 | 2.3542 | 738288.8 | 492192.5 | 2424.1 | 2042.6 |
| 800 | 34 | 144 | 800 | 3.537 | 3627.89 | 2.2178 | 676334.8 | 450889.9 | 2220.7 | 1815.6 |
| 700 | 34 | 144 | 800 | 3.537 | 3274.41 | 2.0674 | 614026.7 | 409351.2 | 2016.1 | 1588.7 |
| 600 | 34 | 144 | 800 | 3.537 | 2920.92 | 1.8998 | 551324.6 | 367549.7 | 1810.2 | 1361.7 |
| 500 | 34 | 144 | 800 | 3.537 | 2567.43 | 1.7106 | 488178.3 | 325452.2 | 1602.9 | 1134.8 |
| 400 | 34 | 144 | 800 | 3.537 | 2213.95 | 1.4933 | 424523.9 | 283016.0 | 1393.9 | 907.8 |
| 300 | 34 | 144 | 800 | 3.537 | 1860.46 | 1.2381 | 360276.0 | 240184.0 | 1182.9 | 680.9 |
| 200 | 34 | 144 | 800 | 3.537 | 1506.97 | 0.9290 | 295315.7 | 196877.1 | 969.6 | 453.9 |
| 100 | 34 | 144 | 800 | 3.537 | 1153.49 | 0.5368 | 229465.4 | 152976.9 | 753.4 | 227.0 |
| 0 | 34 | 144 | 800 | 3.537 | 800.00 | 0.0000 | 162432.0 | 108288.0 | 533.3 | 0.0 |
| 1350 | 34 | 144 | 4500 | 3.537 | 9272.07 | 1.0605 | 1807846.5 | ********* | 5935.9 | 3063.8 |
| 1300 | 34 | 144 | 4500 | 3.537 | 9095.33 | 1.0323 | 1775312.2 | ********* | 5829.1 | 2950.4 |
| 1200 | 34 | 144 | 4500 | 3.537 | 8741.84 | 0.9742 | 1710133.7 | ********* | 5615.1 | 2723.4 |
| 1100 | 34 | 144 | 4500 | 3.537 | 8388.36 | 0.9136 | 1644803.5 | ********* | 5400.6 | 2496.5 |
| 1000 | 34 | 144 | 4500 | 3.537 | 8034.87 | 0.8504 | 1579314.9 | ********* | 5185.6 | 2269.5 |
| 900 | 34 | 144 | 4500 | 3.537 | 7681.38 | 0.7844 | 1513660.6 | ********* | 4970.0 | 2042.6 |
| 800 | 34 | 144 | 4500 | 3.537 | 7327.89 | 0.7153 | 1447832.7 | 965221.8 | 4753.9 | 1815.6 |
| 700 | 34 | 144 | 4500 | 3.537 | 6974.41 | 0.6428 | 1381822.5 | 921215.0 | 4537.1 | 1588.7 |
| 600 | 34 | 144 | 4500 | 3.537 | 6620.92 | 0.5665 | 1315620.4 | 877080.3 | 4319.7 | 1361.7 |
| 500 | 34 | 144 | 4500 | 3.537 | 6267.43 | 0.4860 | 1249215.7 | 832810.5 | 4101.7 | 1134.8 |
| 400 | 34 | 144 | 4500 | 3.537 | 5913.95 | 0.4008 | 1182596.5 | 788397.7 | 3883.0 | 907.8 |
| 300 | 34 | 144 | 4500 | 3.537 | 5560.46 | 0.3104 | 1115749.6 | 743833.0 | 3663.5 | 680.9 |
| 200 | 34 | 144 | 4500 | 3.537 | 5206.97 | 0.2141 | 1048659.7 | 699106.4 | 3443.2 | 453.9 |
| 100 | 34 | 144 | 4500 | 3.537 | 4853.49 | 0.1109 | 981309.7 | 654206.5 | 3222.1 | 227.0 |
| 0 | 34 | 144 | 4500 | 3.537 | 4500.00 | 0.0000 | 913680.0 | 609120.0 | 3000.0 | 0.0 |
| 1350 | 35 | 144 | 800 | 3.690 | 5778.54 | 2.6783 | 1058020.9 | 705347.2 | 3473.9 | 3063.8 |
| 1300 | 35 | 144 | 800 | 3.690 | 5594.15 | 2.6344 | 1026027.8 | 684018.5 | 3368.9 | 2950.4 |
| 1200 | 35 | 144 | 800 | 3.690 | 5225.37 | 2.5420 | 961868.2 | 641245.4 | 3158.2 | 2723.4 |
| 1100 | 35 | 144 | 800 | 3.690 | 4856.59 | 2.4429 | 897463.1 | 598308.7 | 2946.8 | 2496.5 |
| 1000 | 35 | 144 | 800 | 3.690 | 4487.81 | 2.3359 | 832793.2 | 555195.5 | 2734.4 | 2269.5 |
| 900 | 35 | 144 | 800 | 3.690 | 4119.03 | 2.2198 | 767835.9 | 511890.6 | 2521.1 | 2042.6 |
| 800 | 35 | 144 | 800 | 3.690 | 3750.25 | 2.0927 | 702564.2 | 468376.1 | 2306.8 | 1815.6 |
| 700 | 35 | 144 | 800 | 3.690 | 3381.47 | 1.9525 | 636946.0 | 424630.7 | 2091.4 | 1588.7 |
| 600 | 35 | 144 | 800 | 3.690 | 3012.69 | 1.7961 | 570941.9 | 380627.9 | 1874.6 | 1361.7 |
| 500 | 35 | 144 | 800 | 3.690 | 2643.91 | 1.6192 | 504502.5 | 336335.0 | 1656.5 | 1134.8 |
| 400 | 35 | 144 | 800 | 3.690 | 2275.12 | 1.4157 | 437564.5 | 291709.6 | 1436.7 | 907.8 |
| 300 | 35 | 144 | 800 | 3.690 | 1906.34 | 1.1762 | 370042.9 | 246695.3 | 1215.0 | 680.9 |
| 200 | 35 | 144 | 800 | 3.690 | 1537.56 | 0.8850 | 301819.3 | 201212.8 | 991.0 | 453.9 |
| 100 | 35 | 144 | 800 | 3.690 | 1168.78 | 0.5135 | 232715.0 | 155143.4 | 764.1 | 227.0 |
| 0 | 35 | 144 | 800 | 3.690 | 800.00 | 0.0000 | 162432.0 | 108288.0 | 533.3 | 0.0 |
| 1350 | 35 | 144 | 4500 | 3.690 | 9478.54 | 1.0091 | 1851764.7 | ********* | 6080.1 | 3063.8 |
| 1300 | 35 | 144 | 4500 | 3.690 | 9294.15 | 0.9825 | 1817599.6 | ********* | 5968.0 | 2950.4 |
| 1200 | 35 | 144 | 4500 | 3.690 | 8925.37 | 0.9276 | 1749160.6 | ********* | 5743.2 | 2723.4 |
| 1100 | 35 | 144 | 4500 | 3.690 | 8556.59 | 0.8705 | 1680571.7 | ********* | 5518.0 | 2496.5 |
| 1000 | 35 | 144 | 4500 | 3.690 | 8187.81 | 0.8108 | 1611826.0 | ********* | 5292.3 | 2269.5 |
| 900 | 35 | 144 | 4500 | 3.690 | 7819.03 | 0.7484 | 1542916.3 | ********* | 5066.1 | 2042.6 |
| 800 | 35 | 144 | 4500 | 3.690 | 7450.25 | 0.6829 | 1473834.5 | 982556.3 | 4839.2 | 1815.6 |
| 700 | 35 | 144 | 4500 | 3.690 | 7081.47 | 0.6142 | 1404571.8 | 936381.2 | 4611.8 | 1588.7 |
| 600 | 35 | 144 | 4500 | 3.690 | 6712.69 | 0.5417 | 1335118.5 | 890079.0 | 4383.8 | 1361.7 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 35 | 144 | 4500 | 3.690 | 6343.91 | 0.4652 | 1265463.6 | 843642.4 | 4155.1 | 1134.8 |
| 400 | 35 | 144 | 4500 | 3.690 | 5975.12 | 0.3841 | 1195595.0 | 797063.3 | 3925.6 | 907.8 |
| 300 | 35 | 144 | 4500 | 3.690 | 5606.34 | 0.2978 | 1125499.1 | 750332.7 | 3695.5 | 680.9 |
| 200 | 35 | 144 | 4500 | 3.690 | 5237.56 | 0.2056 | 1055160.2 | 703440.1 | 3464.5 | 453.9 |
| 100 | 35 | 144 | 4500 | 3.690 | 4868.78 | 0.1067 | 984560.7 | 656373.8 | 3232.7 | 227.0 |
| 0 | 35 | 144 | 4500 | 3.690 | 4500.00 | 0.0000 | 913680.0 | 609120.0 | 3000.0 | 0.0 |
| 1350 | 40 | 144 | 800 | 4.599 | 7004.55 | 1.9679 | 1318615.6 | 879077.1 | 4329.6 | 3063.8 |
| 1300 | 40 | 144 | 800 | 4.599 | 6774.76 | 1.9376 | 1276858.1 | 851238.7 | 4192.5 | 2950.4 |
| 1200 | 40 | 144 | 800 | 4.599 | 6315.16 | 1.8739 | 1193189.2 | 795459.5 | 3917.7 | 2723.4 |
| 1100 | 40 | 144 | 800 | 4.599 | 5855.56 | 1.8054 | 1109302.7 | 739535.1 | 3642.3 | 2496.5 |
| 1000 | 40 | 144 | 800 | 4.599 | 5395.97 | 1.7312 | 1025180.8 | 683453.9 | 3366.1 | 2269.5 |
| 900 | 40 | 144 | 800 | 4.599 | 4936.37 | 1.6505 | 940803.1 | 627202.1 | 3089.1 | 2042.6 |
| 800 | 40 | 144 | 800 | 4.599 | 4476.77 | 1.5619 | 856145.1 | 570763.4 | 2811.1 | 1815.6 |
| 700 | 40 | 144 | 800 | 4.599 | 4017.18 | 1.4636 | 771177.1 | 514118.0 | 2532.1 | 1588.7 |
| 600 | 40 | 144 | 800 | 4.599 | 3557.58 | 1.3534 | 685862.6 | 457241.7 | 2252.0 | 1361.7 |
| 500 | 40 | 144 | 800 | 4.599 | 3097.98 | 1.2280 | 600155.4 | 400103.6 | 1970.6 | 1134.8 |
| 400 | 40 | 144 | 800 | 4.599 | 2638.39 | 1.0823 | 513995.5 | 342663.6 | 1687.7 | 907.8 |
| 300 | 40 | 144 | 800 | 4.599 | 2178.79 | 0.9087 | 427301.0 | 284867.4 | 1403.0 | 680.9 |
| 200 | 40 | 144 | 800 | 4.599 | 1719.19 | 0.6938 | 339954.8 | 226636.5 | 1116.2 | 453.9 |
| 100 | 40 | 144 | 800 | 4.599 | 1259.60 | 0.4117 | 251773.8 | 167849.2 | 826.7 | 227.0 |
| 0 | 40 | 144 | 800 | 4.599 | 800.00 | 0.0000 | 162432.0 | 108288.0 | 533.3 | 0.0 |
| 1350 | 40 | 144 | 4500 | 4.599 | 10704.55 | 0.7860 | 2109269.2 | ********* | 6925.6 | 3063.8 |
| 1300 | 40 | 144 | 4500 | 4.599 | 10474.76 | 0.7663 | 2065546.4 | ********* | 6782.1 | 2950.4 |
| 1200 | 40 | 144 | 4500 | 4.599 | 10015.16 | 0.7256 | 1977998.7 | ********* | 6494.6 | 2723.4 |
| 1100 | 40 | 144 | 4500 | 4.599 | 9555.56 | 0.6830 | 1890309.7 | ********* | 6206.7 | 2496.5 |
| 1000 | 40 | 144 | 4500 | 4.599 | 9095.97 | 0.6383 | 1802472.2 | ********* | 5918.3 | 2269.5 |
| 900 | 40 | 144 | 4500 | 4.599 | 8636.37 | 0.5913 | 1714478.7 | ********* | 5629.4 | 2042.6 |
| 800 | 40 | 144 | 4500 | 4.599 | 8176.77 | 0.5417 | 1626320.5 | ********* | 5339.9 | 1815.6 |
| 700 | 40 | 144 | 4500 | 4.599 | 7717.18 | 0.4892 | 1537988.3 | ********* | 5049.9 | 1588.7 |
| 600 | 40 | 144 | 4500 | 4.599 | 7257.58 | 0.4335 | 1449471.4 | 966314.3 | 4759.2 | 1361.7 |
| 500 | 40 | 144 | 4500 | 4.599 | 6797.98 | 0.3742 | 1360757.7 | 907171.8 | 4467.9 | 1134.8 |
| 400 | 40 | 144 | 4500 | 4.599 | 6338.39 | 0.3107 | 1271833.7 | 847889.2 | 4176.0 | 907.8 |
| 300 | 40 | 144 | 4500 | 4.599 | 5878.79 | 0.2424 | 1182683.8 | 788455.8 | 3883.3 | 680.9 |
| 200 | 40 | 144 | 4500 | 4.599 | 5419.19 | 0.1686 | 1093289.6 | 728859.8 | 3589.7 | 453.9 |
| 100 | 40 | 144 | 4500 | 4.599 | 4959.60 | 0.0882 | 1003630.1 | 669086.8 | 3295.3 | 227.0 |
| 0 | 40 | 144 | 4500 | 4.599 | 4500.00 | 0.0000 | 913680.0 | 609120.0 | 3000.0 | 0.0 |

FARMER '68, WILSON '72, JAEGER COOK '69

$\Phi$ - INTERNAL FRICTION ANGLE RANGE 30-40°

$\sigma_o$ - CONFINING STRESS MASS COHESION RANGE 800-4600 PSI

$\tan B$ = PASSIVE PRESSURE COEFFICIENT

$= 1+\sin\Phi / 1-\sin\Phi$

$\hat{\sigma_v}$ = MAX. STABLE VERT. PILLAR STRESS

$= (6.94\times10^{-5})(\text{OVB DENSITY LB/FT}^3)(\text{OVB DEPTH})(\tan B) + \sigma_o$ PSI

$\hat{y}$ = DIST. PILLAR LOCATION MAX. STABLE PILLAR CORE

$= (\text{SEAM HEIGHT})\left(\ln \frac{\hat{\sigma_v}}{\sigma_o}\right)/(\tan B)^{1/2}(\tan B - 1)$ FT

WIDE PILLAR ALL CASES PILLAR WIDE $> 2\hat{y}$

L = LOAD CAPACITY PILLAR

$= (7.2\times10^{-2})(\hat{\sigma_v})\left[(\text{WIDTH})(\text{LENGTH}) - (\text{WIDTH})(\hat{y}) - (\text{LENGTH})(\hat{y}) + \frac{4}{3}(\hat{y})^2\right]$ TONS

DESIGN LOAD = $L/1.5$

DESIGN STRESS = (DESIGN LOAD)(2000) / (WIDTH)(LENGTH)(144) PSI

ACTUAL STRESS = (OVB)(1 PSI/FT)($80^2$) / (WIDTH)(LENGTH)

EXHIBIT 2

| OVERBURDEN | ANGLE OF INTERNAL FRICTION | OVERBURDEN DENSITY | CONFINING STRESS | TAN B | MAXIMUM STABLE VERT STRESS | DISTANCE TO MAX VERT STRESS | SQUARE LOAD CARRY CAPACITY | DESIGN LOAD CAPACITY | DESIGN STRESS | NORMAL STRESS PILLAR |
|---|---|---|---|---|---|---|---|---|---|---|
| FEET | DEGREE | LB/FT3 | PSI | | PSI | FEET | TONS | TONS | PSI | PSI |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 462941.8 | 308627.9 | 2679.1 | 5400.0 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 450136.4 | 300091.0 | 2605.0 | 5200.0 |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 424388.2 | 282925.5 | 2456.0 | 4800.0 |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 398445.3 | 265630.2 | 2305.8 | 4400.0 |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 372292.1 | 248194.7 | 2154.5 | 4000.0 |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 345910.6 | 230607.1 | 2001.8 | 3600.0 |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 319279.7 | 212853.1 | 1847.7 | 3200.0 |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 292373.7 | 194915.8 | 1692.0 | 2800.0 |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 265161.8 | 176774.5 | 1534.5 | 2400.0 |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 237605.5 | 158403.7 | 1375.0 | 2000.0 |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 209656.0 | 139770.6 | 1213.3 | 1600.0 |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 181248.7 | 120832.5 | 1048.9 | 1200.0 |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 152295.4 | 101530.2 | 881.3 | 800.0 |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 122667.2 | 81778.2 | 709.9 | 400.0 |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 92160.0 | 61440.0 | 533.3 | 0.0 |
| 1350 | 32 | 144 | 800 | 3.255 | 5190.88 | 3.2184 | 506923.8 | 337949.2 | 2933.6 | 5400.0 |
| 1300 | 32 | 144 | 800 | 3.255 | 5028.26 | 3.1636 | 492460.2 | 328306.8 | 2849.9 | 5200.0 |
| 1200 | 32 | 144 | 800 | 3.255 | 4703.01 | 3.0485 | 463400.4 | 308933.6 | 2681.7 | 4800.0 |
| 1100 | 32 | 144 | 800 | 3.255 | 4377.76 | 2.9252 | 434153.0 | 289435.3 | 2512.5 | 4400.0 |
| 1000 | 32 | 144 | 800 | 3.255 | 4052.51 | 2.7923 | 404702.9 | 269801.9 | 2342.0 | 4000.0 |
| 900 | 32 | 144 | 800 | 3.255 | 3727.25 | 2.6483 | 375032.7 | 250021.8 | 2170.3 | 3600.0 |
| 800 | 32 | 144 | 800 | 3.255 | 3402.00 | 2.4912 | 345121.8 | 230081.2 | 1997.2 | 3200.0 |
| 700 | 32 | 144 | 800 | 3.255 | 3076.75 | 2.3182 | 314945.5 | 209963.7 | 1822.6 | 2800.0 |
| 600 | 32 | 144 | 800 | 3.255 | 2751.50 | 2.1259 | 284473.6 | 189649.1 | 1646.3 | 2400.0 |
| 500 | 32 | 144 | 800 | 3.255 | 2426.25 | 1.9094 | 253668.6 | 169112.4 | 1468.0 | 2000.0 |
| 400 | 32 | 144 | 800 | 3.255 | 2101.00 | 1.6617 | 222482.5 | 148321.7 | 1287.5 | 1600.0 |
| 300 | 32 | 144 | 800 | 3.255 | 1775.75 | 1.3723 | 190851.5 | 127234.4 | 1104.5 | 1200.0 |
| 200 | 32 | 144 | 800 | 3.255 | 1450.50 | 1.0241 | 158687.6 | 105791.7 | 918.3 | 800.0 |
| 100 | 32 | 144 | 800 | 3.255 | 1125.25 | 0.5871 | 125860.7 | 83907.1 | 728.4 | 400.0 |
| 0 | 32 | 144 | 800 | 3.255 | 800.00 | 0.0000 | 92160.0 | 61440.0 | 533.3 | 0.0 |
| 1350 | 34 | 144 | 800 | 3.537 | 5572.07 | 2.8473 | 554854.6 | 369903.0 | 3211.0 | 5400.0 |
| 1300 | 34 | 144 | 800 | 3.537 | 5395.33 | 2.8000 | 538586.1 | 359057.4 | 3116.8 | 5200.0 |
| 1200 | 34 | 144 | 800 | 3.537 | 5041.84 | 2.7006 | 505921.6 | 337281.1 | 2927.8 | 4800.0 |
| 1100 | 34 | 144 | 800 | 3.537 | 4688.36 | 2.5940 | 473076.7 | 315384.5 | 2737.7 | 4400.0 |
| 1000 | 34 | 144 | 800 | 3.537 | 4334.87 | 2.4790 | 440036.9 | 293357.9 | 2546.5 | 4000.0 |
| 900 | 34 | 144 | 800 | 3.537 | 3981.38 | 2.3542 | 406785.2 | 271190.2 | 2354.1 | 3600.0 |
| 800 | 34 | 144 | 800 | 3.537 | 3627.89 | 2.2178 | 373301.9 | 248867.9 | 2160.3 | 3200.0 |
| 700 | 34 | 144 | 800 | 3.537 | 3274.41 | 2.0674 | 339562.8 | 226375.2 | 1965.1 | 2800.0 |
| 600 | 34 | 144 | 800 | 3.537 | 2920.92 | 1.8998 | 305538.6 | 203692.4 | 1768.2 | 2400.0 |
| 500 | 34 | 144 | 800 | 3.537 | 2567.43 | 1.7106 | 271192.7 | 180795.1 | 1569.4 | 2000.0 |
| 400 | 34 | 144 | 800 | 3.537 | 2213.95 | 1.4933 | 236477.8 | 157651.9 | 1368.5 | 1600.0 |
| 300 | 34 | 144 | 800 | 3.537 | 1860.46 | 1.2381 | 201331.1 | 134220.7 | 1165.1 | 1200.0 |
| 200 | 34 | 144 | 800 | 3.537 | 1506.97 | 0.9290 | 165664.6 | 110443.1 | 958.7 | 800.0 |
| 100 | 34 | 144 | 800 | 3.537 | 1153.49 | 0.5368 | 129346.9 | 86231.3 | 748.5 | 400.0 |
| 0 | 34 | 144 | 800 | 3.537 | 800.00 | 0.0000 | 92160.0 | 61440.0 | 533.3 | 0.0 |
| 1350 | 35 | 144 | 800 | 3.690 | 5778.54 | 2.6783 | 580520.7 | 387013.8 | 3359.5 | 5400.0 |
| 1300 | 35 | 144 | 800 | 3.690 | 5594.15 | 2.6344 | 563286.7 | 375524.4 | 3259.8 | 5200.0 |
| 1200 | 35 | 144 | 800 | 3.690 | 5225.37 | 2.5420 | 528693.8 | 352462.5 | 3059.6 | 4800.0 |
| 1100 | 35 | 144 | 800 | 3.690 | 4856.59 | 2.4429 | 493924.1 | 329282.7 | 2858.4 | 4400.0 |
| 1000 | 35 | 144 | 800 | 3.690 | 4487.81 | 2.3359 | 458963.3 | 305975.5 | 2656.0 | 4000.0 |
| 900 | 35 | 144 | 800 | 3.690 | 4119.03 | 2.2198 | 423795.0 | 282530.0 | 2452.5 | 3600.0 |
| 800 | 35 | 144 | 800 | 3.690 | 3750.25 | 2.0927 | 388399.4 | 258932.9 | 2247.7 | 3200.0 |
| 700 | 35 | 144 | 800 | 3.690 | 3381.47 | 1.9525 | 352752.9 | 235168.6 | 2041.4 | 2800.0 |
| 600 | 35 | 144 | 800 | 3.690 | 3012.69 | 1.7961 | 316826.6 | 211217.8 | 1833.5 | 2400.0 |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 35 | 144 | 800 | 3.690 | 2643.91 | 1.6192 | 280584.3 | 187056.2 | 1623.8 | 2000.0 |
| 400 | 35 | 144 | 800 | 3.690 | 2275.12 | 1.4157 | 243979.2 | 162652.8 | 1411.9 | 1600.0 |
| 300 | 35 | 144 | 800 | 3.690 | 1906.34 | 1.1762 | 206948.7 | 137965.8 | 1197.6 | 1200.0 |
| 200 | 35 | 144 | 800 | 3.690 | 1537.56 | 0.8850 | 169405.0 | 112936.7 | 980.4 | 800.0 |
| 100 | 35 | 144 | 800 | 3.690 | 1168.78 | 0.5135 | 131216.1 | 87477.4 | 759.4 | 400.0 |
| 0 | 35 | 144 | 800 | 3.690 | 800.00 | 0.0000 | 92160.0 | 61440.0 | 533.3 | 0.0 |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 598566.6 | 399044.4 | 2736.9 | 4266.7 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 581781.8 | 387854.5 | 2660.2 | 4108.6 |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 548053.6 | 365369.0 | 2506.0 | 3792.6 |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 514100.8 | 342733.9 | 2350.7 | 3476.5 |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 479906.0 | 319937.3 | 2194.4 | 3160.5 |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 445448.3 | 296965.6 | 2036.8 | 2844.4 |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 410703.7 | 273802.5 | 1877.9 | 2528.4 |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 375643.2 | 250428.8 | 1717.6 | 2212.3 |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 340231.6 | 226821.0 | 1555.7 | 1896.3 |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 304425.1 | 202950.1 | 1392.0 | 1580.2 |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 268168.3 | 178778.9 | 1226.2 | 1264.2 |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 231388.2 | 154258.8 | 1058.0 | 948.1 |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 193984.6 | 129323.1 | 887.0 | 632.1 |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 155812.1 | 103874.7 | 712.4 | 316.0 |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 116640.0 | 77760.0 | 533.3 | 0.0 |
| 1350 | 32 | 144 | 800 | 3.255 | 5190.88 | 3.2184 | 653736.3 | 435824.2 | 2989.2 | 4266.7 |
| 1300 | 32 | 144 | 800 | 3.255 | 5028.26 | 3.1636 | 634871.6 | 423247.7 | 2902.9 | 4108.6 |
| 1200 | 32 | 144 | 800 | 3.255 | 4703.01 | 3.0485 | 596989.7 | 397993.1 | 2729.7 | 3792.6 |
| 1100 | 32 | 144 | 800 | 3.255 | 4377.76 | 2.9252 | 558892.3 | 372594.8 | 2555.5 | 3476.5 |
| 1000 | 32 | 144 | 800 | 3.255 | 4052.51 | 2.7923 | 520562.2 | 347041.5 | 2380.3 | 3160.5 |
| 900 | 32 | 144 | 800 | 3.255 | 3727.25 | 2.6483 | 481979.6 | 321319.8 | 2203.8 | 2844.4 |
| 800 | 32 | 144 | 800 | 3.255 | 3402.00 | 2.4912 | 443121.2 | 295414.1 | 2026.2 | 2528.4 |
| 700 | 32 | 144 | 800 | 3.255 | 3076.75 | 2.3182 | 403958.7 | 269305.8 | 1847.1 | 2212.3 |
| 600 | 32 | 144 | 800 | 3.255 | 2751.50 | 2.1259 | 364458.0 | 242972.0 | 1666.5 | 1896.3 |
| 500 | 32 | 144 | 800 | 3.255 | 2426.25 | 1.9094 | 324576.4 | 216384.2 | 1484.1 | 1580.2 |
| 400 | 32 | 144 | 800 | 3.255 | 2101.00 | 1.6617 | 284259.4 | 189506.3 | 1299.8 | 1264.2 |
| 300 | 32 | 144 | 800 | 3.255 | 1775.75 | 1.3723 | 243435.0 | 162290.0 | 1113.1 | 948.1 |
| 200 | 32 | 144 | 800 | 3.255 | 1450.50 | 1.0241 | 202003.4 | 134668.9 | 923.7 | 632.1 |
| 100 | 32 | 144 | 800 | 3.255 | 1125.25 | 0.5871 | 159817.7 | 106545.1 | 730.8 | 316.0 |
| 0 | 32 | 144 | 800 | 3.255 | 800.00 | 0.0000 | 116640.0 | 77760.0 | 533.3 | 0.0 |
| 1350 | 34 | 144 | 800 | 3.537 | 5572.07 | 2.8473 | 713936.9 | 475957.9 | 3264.5 | 4266.7 |
| 1300 | 34 | 144 | 800 | 3.537 | 5395.33 | 2.8000 | 692806.0 | 461870.7 | 3167.8 | 4108.6 |
| 1200 | 34 | 144 | 800 | 3.537 | 5041.84 | 2.7006 | 650398.4 | 433598.9 | 2973.9 | 3792.6 |
| 1100 | 34 | 144 | 800 | 3.537 | 4688.36 | 2.5940 | 607784.1 | 405189.4 | 2779.1 | 3476.5 |
| 1000 | 34 | 144 | 800 | 3.537 | 4334.87 | 2.4790 | 564946.7 | 376631.1 | 2583.2 | 3160.5 |
| 900 | 34 | 144 | 800 | 3.537 | 3981.38 | 2.3542 | 521867.0 | 347911.3 | 2386.2 | 2844.4 |
| 800 | 34 | 144 | 800 | 3.537 | 3627.89 | 2.2178 | 478522.3 | 319014.9 | 2188.0 | 2528.4 |
| 700 | 34 | 144 | 800 | 3.537 | 3274.41 | 2.0674 | 434885.6 | 289923.7 | 1988.5 | 2212.3 |
| 600 | 34 | 144 | 800 | 3.537 | 2920.92 | 1.8998 | 390923.3 | 260615.5 | 1787.5 | 1896.3 |
| 500 | 34 | 144 | 800 | 3.537 | 2567.43 | 1.7106 | 346594.0 | 231062.7 | 1584.8 | 1580.2 |
| 400 | 34 | 144 | 800 | 3.537 | 2213.95 | 1.4933 | 301844.2 | 201229.5 | 1380.2 | 1264.2 |
| 300 | 34 | 144 | 800 | 3.537 | 1860.46 | 1.2381 | 256602.7 | 171068.4 | 1173.3 | 948.1 |
| 200 | 34 | 144 | 800 | 3.537 | 1506.97 | 0.9290 | 210770.0 | 140513.3 | 963.7 | 632.1 |
| 100 | 34 | 144 | 800 | 3.537 | 1153.49 | 0.5368 | 164197.8 | 109465.2 | 750.8 | 316.0 |
| 0 | 34 | 144 | 800 | 3.537 | 800.00 | 0.0000 | 116640.0 | 77760.0 | 533.3 | 0.0 |
| 1350 | 35 | 144 | 800 | 3.690 | 5778.54 | 2.6783 | 746200.7 | 497467.2 | 3412.0 | 4266.7 |
| 1300 | 35 | 144 | 800 | 3.690 | 5594.15 | 2.6344 | 723856.9 | 482571.3 | 3309.8 | 4108.6 |
| 1200 | 35 | 144 | 800 | 3.690 | 5225.37 | 2.5420 | 679026.4 | 452684.2 | 3104.8 | 3792.6 |
| 1100 | 35 | 144 | 800 | 3.690 | 4856.59 | 2.4429 | 633993.6 | 422662.4 | 2898.9 | 3476.5 |
| 1000 | 35 | 144 | 800 | 3.690 | 4487.81 | 2.3339 | 588742.4 | 392494.9 | 2692.0 | 3160.5 |
| 900 | 35 | 144 | 800 | 3.690 | 4119.03 | 2.2198 | 543254.1 | 362169.4 | 2484.0 | 2844.4 |
| 800 | 35 | 144 | 800 | 3.690 | 3750.25 | 2.0927 | 497506.2 | 331670.8 | 2274.8 | 2528.4 |
| 700 | 35 | 144 | 800 | 3.690 | 3381.47 | 1.9525 | 451472.1 | 300981.4 | 2064.3 | 2212.3 |
| 600 | 35 | 144 | 800 | 3.690 | 3012.69 | 1.7961 | 405118.9 | 270079.2 | 1852.4 | 1896.3 |

40×40
45×45

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 35 | 144 | 800 | 3.690 | 2643.91 | 1.6192 | 358405.4 | 238937.0 | 1638.8 | 1580.2 |
| 400 | 35 | 144 | 800 | 3.690 | 2275.12 | 1.4157 | 311278.8 | 207519.2 | 1423.3 | 1264.2 |
| 300 | 35 | 144 | 800 | 3.690 | 1906.34 | 1.1762 | 263668.3 | 175778.9 | 1205.6 | 948.1 |
| 200 | 35 | 144 | 800 | 3.690 | 1537.56 | 0.8850 | 215474.7 | 143649.8 | 985.3 | 632.1 |
| 100 | 35 | 144 | 800 | 3.690 | 1168.78 | 0.5135 | 166548.6 | 111032.4 | 761.5 | 316.0 |
| 0 | 35 | 144 | 800 | 3.690 | 800.00 | 0.0000 | 116640.0 | 77760.0 | 533.3 | 0.0 |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 657702.7 | 438468.5 | 2756.8 | 3911.3 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 639175.0 | 426116.7 | 2679.2 | 3766.4 |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 601952.6 | 401301.7 | 2523.1 | 3476.7 |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 564493.7 | 376329.2 | 2366.1 | 3187.0 |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 526780.0 | 351186.6 | 2208.1 | 2897.2 |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 488789.7 | 325859.8 | 2048.8 | 2607.5 |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 450497.4 | 300331.6 | 1888.3 | 2317.8 |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 411872.9 | 274581.9 | 1726.4 | 2028.1 |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 372879.1 | 248586.1 | 1563.0 | 1738.3 |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 333470.4 | 222313.6 | 1397.8 | 1448.6 |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 293588.5 | 195725.7 | 1230.6 | 1158.9 |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 253157.0 | 168771.3 | 1061.1 | 869.2 |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 212071.1 | 141380.8 | 888.9 | 579.4 |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 170178.6 | 113452.4 | 713.3 | 289.7 |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 127238.4 | 84825.6 | 533.3 | 0.0 |
| 1350 | 32 | 144 | 800 | 3.255 | 5190.88 | 3.2184 | 717693.8 | 478462.5 | 3008.3 | 3911.3 |
| 1300 | 32 | 144 | 800 | 3.255 | 5028.26 | 3.1636 | 696904.6 | 464603.1 | 2921.2 | 3766.4 |
| 1200 | 32 | 144 | 800 | 3.255 | 4703.01 | 3.0485 | 655166.0 | 436777.4 | 2746.2 | 3476.7 |
| 1100 | 32 | 144 | 800 | 3.255 | 4377.76 | 2.9252 | 613200.7 | 408800.5 | 2570.3 | 3187.0 |
| 1000 | 32 | 144 | 800 | 3.255 | 4052.51 | 2.7923 | 570990.8 | 380660.6 | 2393.4 | 2897.2 |
| 900 | 32 | 144 | 800 | 3.255 | 3727.25 | 2.6483 | 528515.5 | 352343.7 | 2215.3 | 2607.5 |
| 800 | 32 | 144 | 800 | 3.255 | 3402.00 | 2.4912 | 485750.1 | 323833.4 | 2036.1 | 2317.8 |
| 700 | 32 | 144 | 800 | 3.255 | 3076.75 | 2.3182 | 442665.3 | 295110.2 | 1855.5 | 2028.1 |
| 600 | 32 | 144 | 800 | 3.255 | 2751.50 | 2.1259 | 399225.2 | 266150.1 | 1673.4 | 1738.3 |
| 500 | 32 | 144 | 800 | 3.255 | 2426.25 | 1.9094 | 355385.1 | 236923.4 | 1489.6 | 1448.6 |
| 400 | 32 | 144 | 800 | 3.255 | 2101.00 | 1.6617 | 311088.0 | 207392.0 | 1304.0 | 1158.9 |
| 300 | 32 | 144 | 800 | 3.255 | 1775.75 | 1.3723 | 266258.4 | 177505.6 | 1116.1 | 869.2 |
| 200 | 32 | 144 | 800 | 3.255 | 1450.50 | 1.0241 | 220791.8 | 147194.6 | 925.5 | 579.4 |
| 100 | 32 | 144 | 800 | 3.255 | 1125.25 | 0.5871 | 174534.8 | 116356.5 | 731.6 | 289.7 |
| 0 | 32 | 144 | 800 | 3.255 | 800.00 | 0.0000 | 127238.4 | 84825.6 | 533.3 | 0.0 |
| 1350 | 34 | 144 | 800 | 3.537 | 5572.07 | 2.8473 | 783186.5 | 522124.3 | 3282.8 | 3911.3 |
| 1300 | 34 | 144 | 800 | 3.537 | 5395.33 | 2.8000 | 759932.5 | 506621.7 | 3185.3 | 3766.4 |
| 1200 | 34 | 144 | 800 | 3.537 | 5041.84 | 2.7006 | 713271.3 | 475514.2 | 2989.8 | 3476.7 |
| 1100 | 34 | 144 | 800 | 3.537 | 4688.36 | 2.5940 | 666392.9 | 444261.9 | 2793.3 | 3187.0 |
| 1000 | 34 | 144 | 800 | 3.537 | 4334.87 | 2.4790 | 619280.1 | 412853.4 | 2595.8 | 2897.2 |
| 900 | 34 | 144 | 800 | 3.537 | 3981.38 | 2.3542 | 571912.9 | 381275.3 | 2397.2 | 2607.5 |
| 800 | 34 | 144 | 800 | 3.537 | 3627.89 | 2.2178 | 524267.5 | 349511.6 | 2197.5 | 2317.8 |
| 700 | 34 | 144 | 800 | 3.537 | 3274.41 | 2.0674 | 476315.3 | 317543.5 | 1996.5 | 2028.1 |
| 600 | 34 | 144 | 800 | 3.537 | 2920.92 | 1.8998 | 428021.5 | 285347.7 | 1794.1 | 1738.3 |
| 500 | 34 | 144 | 800 | 3.537 | 2567.43 | 1.7106 | 379342.5 | 252895.0 | 1590.1 | 1448.6 |
| 400 | 34 | 144 | 800 | 3.537 | 2213.95 | 1.4933 | 330222.4 | 220148.3 | 1384.2 | 1158.9 |
| 300 | 34 | 144 | 800 | 3.537 | 1860.46 | 1.2381 | 280586.7 | 187057.8 | 1176.1 | 869.2 |
| 200 | 34 | 144 | 800 | 3.537 | 1506.97 | 0.9290 | 230331.2 | 153554.2 | 965.5 | 579.4 |
| 100 | 34 | 144 | 800 | 3.537 | 1153.49 | 0.5368 | 179300.8 | 119533.9 | 751.6 | 289.7 |
| 0 | 34 | 144 | 800 | 3.537 | 800.00 | 0.0000 | 127238.4 | 84825.6 | 533.3 | 0.0 |
| 1350 | 35 | 144 | 800 | 3.690 | 5778.54 | 2.6783 | 818297.5 | 545531.7 | 3430.0 | 3911.3 |
| 1300 | 35 | 144 | 800 | 3.690 | 5594.15 | 2.6344 | 793723.9 | 529149.3 | 3327.0 | 3766.4 |
| 1200 | 35 | 144 | 800 | 3.690 | 5225.37 | 2.5420 | 744426.6 | 496284.4 | 3120.3 | 3476.7 |
| 1100 | 35 | 144 | 800 | 3.690 | 4856.59 | 2.4429 | 694916.8 | 463277.9 | 2912.8 | 3187.0 |
| 1000 | 35 | 144 | 800 | 3.690 | 4487.81 | 2.3359 | 645177.8 | 430118.5 | 2704.3 | 2897.2 |
| 900 | 35 | 144 | 800 | 3.690 | 4119.03 | 2.2198 | 595189.7 | 396793.1 | 2494.8 | 2607.5 |
| 800 | 35 | 144 | 800 | 3.690 | 3750.25 | 2.0927 | 544929.2 | 363286.1 | 2284.1 | 2317.8 |
| 700 | 35 | 144 | 800 | 3.690 | 3381.47 | 1.9525 | 494368.3 | 329578.9 | 2072.2 | 2028.1 |
| 600 | 35 | 144 | 800 | 3.690 | 3012.69 | 1.7961 | 443472.5 | 295648.4 | 1858.9 | 1738.3 |

45×45
47×47

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 35 | 144 | 800 | 3.690 | 2643.91 | 1.6192 | 392198.9 | 261466.0 | 1643.9 | 1448.6 | |
| 400 | 35 | 144 | 800 | 3.690 | 2275.12 | 1.4157 | 340492.0 | 226994.7 | 1427.2 | 1158.9 | |
| 300 | 35 | 144 | 800 | 3.690 | 1906.34 | 1.1762 | 288277.8 | 192185.2 | 1208.3 | 869.2 | |
| 200 | 35 | 144 | 800 | 3.690 | 1537.56 | 0.8850 | 235452.5 | 156968.3 | 986.9 | 579.4 | |
| 100 | 35 | 144 | 800 | 3.690 | 1168.78 | 0.5135 | 181859.8 | 121239.9 | 762.3 | 289.7 | |
| 0 | 35 | 144 | 800 | 3.690 | 800.00 | 0.0000 | 127238.4 | 84825.6 | 533.3 | 0.0 | |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 751642.1 | 501094.7 | 2783.9 | 3456.0 | |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 730338.2 | 486892.1 | 2705.0 | 3328.0 | |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 687550.6 | 458367.1 | 2546.5 | 3072.0 | |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 644508.8 | 429672.5 | 2387.1 | 2816.0 | |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 601192.9 | 400795.3 | 2226.6 | 2560.0 | |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 557579.8 | 371719.9 | 2065.1 | 2304.0 | |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 513642.3 | 342428.2 | 1902.4 | 2048.0 | |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 469347.9 | 312898.6 | 1738.3 | 1792.0 | |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 424657.2 | 283104.8 | 1572.8 | 1536.0 | |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 379521.3 | 253014.2 | 1405.6 | 1280.0 | |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 333878.0 | 222585.3 | 1236.6 | 1024.0 | |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 287645.6 | 191763.7 | 1065.4 | 768.0 | |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 240712.5 | 160475.0 | 891.5 | 512.0 | |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 192916.2 | 128610.8 | 714.5 | 256.0 | |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 144000.0 | 96000.0 | 533.3 | 0.0 | |
| 1350 | 32 | 144 | 800 | 3.255 | 5190.88 | 3.2184 | 819236.1 | 546157.4 | 3034.2 | 3456.0 | |
| 1300 | 32 | 144 | 800 | 3.255 | 5028.26 | 3.1636 | 795384.7 | 530256.5 | 2945.9 | 3328.0 | |
| 1200 | 32 | 144 | 800 | 3.255 | 4703.01 | 3.0485 | 747509.8 | 498339.9 | 2768.6 | 3072.0 | |
| 1100 | 32 | 144 | 800 | 3.255 | 4377.76 | 2.9252 | 699391.5 | 466261.0 | 2590.3 | 2816.0 | |
| 1000 | 32 | 144 | 800 | 3.255 | 4052.51 | 2.7923 | 651010.5 | 434007.0 | 2411.2 | 2560.0 | |
| 900 | 32 | 144 | 800 | 3.255 | 3727.25 | 2.6483 | 602344.7 | 401563.1 | 2230.9 | 2304.0 | |
| 800 | 32 | 144 | 800 | 3.255 | 3402.00 | 2.4912 | 553367.7 | 368911.8 | 2049.5 | 2048.0 | = 2049 80. |
| 700 | 32 | 144 | 800 | 3.255 | 3076.75 | 2.3182 | 504048.2 | 336032.1 | 1866.8 | 1792.0 | |
| 600 | 32 | 144 | 800 | 3.255 | 2751.50 | 2.1259 | 454347.7 | 302898.5 | 1682.8 | 1536.0 | |
| 500 | 32 | 144 | 800 | 3.255 | 2426.25 | 1.9094 | 404218.6 | 269479.1 | 1497.1 | 1280.0 | |
| 400 | 32 | 144 | 800 | 3.255 | 2101.00 | 1.6617 | 353600.0 | 235733.3 | 1309.6 | 1024.0 | |
| 300 | 32 | 144 | 800 | 3.255 | 1775.75 | 1.3723 | 302411.2 | 201607.5 | 1120.0 | 768.0 | |
| 200 | 32 | 144 | 800 | 3.255 | 1450.50 | 1.0241 | 250541.0 | 167027.4 | 927.9 | 512.0 | |
| 100 | 32 | 144 | 800 | 3.255 | 1125.25 | 0.5871 | 197825.6 | 131883.7 | 732.7 | 256.0 | |
| 0 | 32 | 144 | 800 | 3.255 | 800.00 | 0.0000 | 144000.0 | 96000.0 | 533.3 | 0.0 | |
| 1350 | 34 | 144 | 800 | 3.537 | 5572.07 | 2.8473 | 893078.6 | 595385.8 | 3307.7 | 3456.0 | |
| 1300 | 34 | 144 | 800 | 3.537 | 5395.33 | 2.8000 | 866449.2 | 577632.8 | 3209.1 | 3328.0 | |
| 1200 | 34 | 144 | 800 | 3.537 | 5041.84 | 2.7006 | 813025.8 | 542017.2 | 3011.2 | 3072.0 | |
| 1100 | 34 | 144 | 800 | 3.537 | 4688.36 | 2.5940 | 759369.5 | 506246.4 | 2812.5 | 2816.0 | |
| 1000 | 34 | 144 | 800 | 3.537 | 4334.87 | 2.4790 | 705462.0 | 470308.0 | 2612.8 | 2560.0 | |
| 900 | 34 | 144 | 800 | 3.537 | 3981.38 | 2.3542 | 651281.7 | 434187.8 | 2412.2 | 2304.0 | |
| 800 | 34 | 144 | 800 | 3.537 | 3627.89 | 2.2178 | 596803.3 | 397868.8 | 2210.4 | 2048.0 | |
| 700 | 34 | 144 | 800 | 3.537 | 3274.41 | 2.0674 | 541996.2 | 361330.8 | 2007.4 | 1792.0 | |
| 600 | 34 | 144 | 800 | 3.537 | 2920.92 | 1.8998 | 486823.4 | 324548.9 | 1803.0 | 1536.0 | |
| 500 | 34 | 144 | 800 | 3.537 | 2567.43 | 1.7106 | 431238.1 | 287492.1 | 1597.2 | 1280.0 | |
| 400 | 34 | 144 | 800 | 3.537 | 2213.95 | 1.4933 | 375180.8 | 250120.6 | 1389.6 | 1024.0 | |
| 300 | 34 | 144 | 800 | 3.537 | 1860.46 | 1.2381 | 318572.0 | 212381.3 | 1179.9 | 768.0 | |
| 200 | 34 | 144 | 800 | 3.537 | 1506.97 | 0.9290 | 261300.6 | 174200.4 | 967.8 | 512.0 | |
| 100 | 34 | 144 | 800 | 3.537 | 1153.49 | 0.5368 | 203201.2 | 135467.4 | 752.6 | 256.0 | |
| 0 | 34 | 144 | 800 | 3.537 | 800.00 | 0.0000 | 144000.0 | 96000.0 | 533.3 | 0.0 | |
| 1350 | 35 | 144 | 800 | 3.690 | 5778.54 | 2.6783 | 932683.6 | 621789.1 | 3454.4 | 3456.0 | |
| 1300 | 35 | 144 | 800 | 3.690 | 5594.15 | 2.6344 | 904566.1 | 603044.1 | 3350.2 | 3328.0 | |
| 1200 | 35 | 144 | 800 | 3.690 | 5225.37 | 2.5420 | 848170.3 | 565446.8 | 3141.4 | 3072.0 | |
| 1100 | 35 | 144 | 800 | 3.690 | 4856.59 | 2.4429 | 791546.8 | 527697.9 | 2931.7 | 2816.0 | |
| 1000 | 35 | 144 | 800 | 3.690 | 4487.81 | 2.3359 | 734677.6 | 489785.1 | 2721.0 | 2560.0 | |
| 900 | 35 | 144 | 800 | 3.690 | 4119.03 | 2.2198 | 677541.7 | 451694.4 | 2509.4 | 2304.0 | |
| 800 | 35 | 144 | 800 | 3.690 | 3750.25 | 2.0927 | 620114.0 | 413409.3 | 2296.7 | 2048.0 | |
| 700 | 35 | 144 | 800 | 3.690 | 3381.47 | 1.9525 | 562364.6 | 374909.7 | 2082.8 | 1792.0 | |
| 600 | 35 | 144 | 800 | 3.690 | 3012.69 | 1.7961 | 504256.8 | 336171.2 | 1867.6 | 1536.0 | |

48/1C

47x47
50x50

5B/1C

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 35 | 144 | 800 | 3.690 | 2643.91 | 1.6192 | 445744.6 | 297163.1 | 1650.9 | 1280.0 |
| 400 | 35 | 144 | 800 | 3.690 | 2275.12 | 1.4157 | 386769.0 | 257846.0 | 1432.5 | 1024.0 |
| 300 | 35 | 144 | 800 | 3.690 | 1906.34 | 1.1762 | 327250.9 | 218167.3 | 1212.0 | 768.0 |
| 200 | 35 | 144 | 800 | 3.690 | 1537.56 | 0.8850 | 267079.6 | 178053.1 | 989.2 | 512.0 |
| 100 | 35 | 144 | 800 | 3.690 | 1168.78 | 0.5135 | 206088.8 | 137392.6 | 763.3 | 256.0 |
| 0 | 35 | 144 | 800 | 3.690 | 800.00 | 0.0000 | 144000.0 | 96000.0 | 533.3 | 0.0 |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 1110145.0 | 740096.7 | 2855.3 | 2400.0 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 1078183.9 | 718789.3 | 2773.1 | 2311.1 |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 1014039.8 | 676026.6 | 2608.1 | 2133.3 |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 949582.0 | 633054.6 | 2442.3 | 1955.6 |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 884786.1 | 589857.4 | 2275.7 | 1777.8 |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 819624.1 | 546416.1 | 2108.1 | 1600.0 |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 754062.8 | 502708.6 | 1939.5 | 1422.2 |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 688062.8 | 458708.5 | 1769.7 | 1244.4 |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 621576.0 | 414384.0 | 1598.7 | 1066.7 |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 554543.2 | 369695.5 | 1426.3 | 888.9 |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 486888.9 | 324592.6 | 1252.3 | 711.1 |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 418514.2 | 279009.5 | 1076.4 | 533.3 |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 349284.1 | 232856.0 | 898.4 | 355.6 |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 279002.4 | 186001.6 | 717.6 | 177.8 |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 207360.0 | 138240.0 | 533.3 | 0.0 |
| 1350 | 32 | 144 | 800 | 3.255 | 5190.88 | 3.2184 | 1206297.1 | 804198.1 | 3102.6 | 2400.0 |
| 1300 | 32 | 144 | 800 | 3.255 | 5028.26 | 3.1636 | 1170716.1 | 780477.4 | 3011.1 | 2311.1 |
| 1200 | 32 | 144 | 800 | 3.255 | 4703.01 | 3.0485 | 1099342.5 | 732895.0 | 2827.5 | 2133.3 |
| 1100 | 32 | 144 | 800 | 3.255 | 4377.76 | 2.9252 | 1027669.6 | 685113.1 | 2643.2 | 1955.6 |
| 1000 | 32 | 144 | 800 | 3.255 | 4052.51 | 2.7923 | 955674.2 | 637116.1 | 2458.0 | 1777.8 |
| 900 | 32 | 144 | 800 | 3.255 | 3727.25 | 2.6483 | 883329.1 | 588886.1 | 2271.9 | 1600.0 |
| 800 | 32 | 144 | 800 | 3.255 | 3402.00 | 2.4912 | 810602.5 | 540401.7 | 2084.9 | 1422.2 |
| 700 | 32 | 144 | 800 | 3.255 | 3076.75 | 2.3182 | 737456.1 | 491637.4 | 1896.7 | 1244.4 |
| 600 | 32 | 144 | 800 | 3.255 | 2751.50 | 2.1259 | 663843.4 | 442562.3 | 1707.4 | 1066.7 |
| 500 | 32 | 144 | 800 | 3.255 | 2426.25 | 1.9094 | 589706.6 | 393137.7 | 1516.7 | 888.9 |
| 400 | 32 | 144 | 800 | 3.255 | 2101.00 | 1.6617 | 514971.8 | 343314.6 | 1324.5 | 711.1 |
| 300 | 32 | 144 | 800 | 3.255 | 1775.75 | 1.3723 | 439541.7 | 293027.8 | 1130.5 | 533.3 |
| 200 | 32 | 144 | 800 | 3.255 | 1450.50 | 1.0241 | 363281.7 | 242187.8 | 934.4 | 355.6 |
| 100 | 32 | 144 | 800 | 3.255 | 1125.25 | 0.5871 | 285994.1 | 190662.7 | 735.6 | 177.8 |
| 0 | 32 | 144 | 800 | 3.255 | 800.00 | 0.0000 | 207360.0 | 138240.0 | 533.3 | 0.0 |
| 1350 | 34 | 144 | 800 | 3.537 | 5572.07 | 2.8473 | 1311540.6 | 874360.4 | 3373.3 | 2400.0 |
| 1300 | 34 | 144 | 800 | 3.537 | 5395.33 | 2.8000 | 1272005.1 | 848003.4 | 3271.6 | 2311.1 |
| 1200 | 34 | 144 | 800 | 3.537 | 5041.84 | 2.7006 | 1192732.5 | 795155.0 | 3067.7 | 2133.3 |
| 1100 | 34 | 144 | 800 | 3.537 | 4688.36 | 2.5940 | 1113174.7 | 742116.5 | 2863.1 | 1955.6 |
| 1000 | 34 | 144 | 800 | 3.537 | 4334.87 | 2.4790 | 1033309.2 | 688872.8 | 2657.7 | 1777.8 |
| 900 | 34 | 144 | 800 | 3.537 | 3981.38 | 2.3542 | 953110.0 | 635406.7 | 2451.4 | 1600.0 |
| 800 | 34 | 144 | 800 | 3.537 | 3627.89 | 2.2178 | 872546.4 | 581697.6 | 2244.2 | 1422.2 |
| 700 | 34 | 144 | 800 | 3.537 | 3274.41 | 2.0674 | 791581.2 | 527720.8 | 2036.0 | 1244.4 |
| 600 | 34 | 144 | 800 | 3.537 | 2920.92 | 1.8998 | 710169.4 | 473446.3 | 1826.6 | 1066.7 |
| 500 | 34 | 144 | 800 | 3.537 | 2567.43 | 1.7106 | 628254.7 | 418836.5 | 1615.9 | 888.9 |
| 400 | 34 | 144 | 800 | 3.537 | 2213.95 | 1.4933 | 545764.7 | 363843.2 | 1403.7 | 711.1 |
| 300 | 34 | 144 | 800 | 3.537 | 1860.46 | 1.2381 | 462603.5 | 308402.3 | 1189.8 | 533.3 |
| 200 | 34 | 144 | 800 | 3.537 | 1506.97 | 0.9290 | 378637.0 | 252424.6 | 973.9 | 355.6 |
| 100 | 34 | 144 | 800 | 3.537 | 1153.49 | 0.5368 | 293665.7 | 195777.1 | 755.3 | 177.8 |
| 0 | 34 | 144 | 800 | 3.537 | 800.00 | 0.0000 | 207360.0 | 138240.0 | 533.3 | 0.0 |
| 1350 | 35 | 144 | 800 | 3.690 | 5778.54 | 2.6783 | 1368057.5 | 912038.3 | 3518.7 | 2400.0 |
| 1300 | 35 | 144 | 800 | 3.690 | 5594.15 | 2.6344 | 1326401.3 | 884267.5 | 3411.5 | 2311.1 |
| 1200 | 35 | 144 | 800 | 3.690 | 5225.37 | 2.5420 | 1242892.1 | 828594.7 | 3196.7 | 2133.3 |
| 1100 | 35 | 144 | 800 | 3.690 | 4856.59 | 2.4429 | 1159104.4 | 772736.3 | 2981.2 | 1955.6 |
| 1000 | 35 | 144 | 800 | 3.690 | 4487.81 | 2.3359 | 1075016.4 | 716677.6 | 2765.0 | 1777.8 |
| 900 | 35 | 144 | 800 | 3.690 | 4119.03 | 2.2198 | 990602.4 | 660401.6 | 2547.8 | 1600.0 |
| 800 | 35 | 144 | 800 | 3.690 | 3750.25 | 2.0927 | 905832.2 | 603888.1 | 2329.8 | 1422.2 |
| 700 | 35 | 144 | 800 | 3.690 | 3381.47 | 1.9525 | 820669.4 | 547112.9 | 2110.8 | 1244.4 |
| 600 | 35 | 144 | 800 | 3.690 | 3012.69 | 1.7961 | 735069.6 | 490046.4 | 1890.6 | 1066.7 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 35 | 144 | 800 | 3.690 | 2643.91 | 1.6192 | 648977.1 | 432651.4 | 1669.2 | 888.9 |
| 400 | 35 | 144 | 800 | 3.690 | 2275.12 | 1.4157 | 562320.6 | 374880.4 | 1446.3 | 711.1 |
| 300 | 35 | 144 | 800 | 3.690 | 1906.34 | 1.1762 | 475004.4 | 316669.6 | 1221.7 | 533.3 |
| 200 | 35 | 144 | 800 | 3.690 | 1537.56 | 0.8850 | 386895.1 | 257930.1 | 995.1 | 355.6 |
| 100 | 35 | 144 | 800 | 3.690 | 1168.78 | 0.5135 | 297792.0 | 198528.0 | 765.9 | 177.8 |
| 0 | 35 | 144 | 800 | 3.690 | 800.00 | 0.0000 | 207360.0 | 138240.0 | 533.3 | 0.0 |

| OVERBURDEN | ANGLE OF INTERNAL FRICTION | OVERBURDEN DENSITY | CONFINING STRESS | TAN B | MAXIMUM STABLE VERT STRESS | DISTANCE TO MAX VERT STRESS | 40 x 40 LOAD CARRY CAPACITY | DESIGN LOAD CAPACITY | DESIGN STRESS | NORMAL STRESS PILLAR |
|---|---|---|---|---|---|---|---|---|---|---|
| FEET | DEGREE | LB/FT3 | PSI | | PSI | FEET | TONS | TONS | PSI | PSI |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 462941.8 | 308627.9 | 2679.1 | 5400 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 450136.4 | 300091.0 | 2605.0 | 5200 |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 424388.2 | 282925.5 | 2456.0 | 4800 |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 398445.3 | 265630.2 | 2305.8 | 4400 |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 372292.1 | 248194.7 | 2154.5 | 4000 |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 345910.6 | 230607.1 | 2001.8 | 3600 |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 319279.7 | 212853.1 | 1847.7 | 3200 |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 292373.7 | 194915.8 | 1692.0 | 2800 |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 265161.8 | 176774.5 | 1534.5 | 2400 |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 237605.5 | 158403.7 | 1375.0 | 2000 |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 209656.0 | 139770.6 | 1213.3 | 1600 |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 181248.7 | 120832.5 | 1048.9 | 1200 |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 152295.4 | 101530.2 | 881.3 | 800 |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 122667.2 | 81778.2 | 709.9 | 400 |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 92160.0 | 61440.0 | 533.3 | 0 |
| 1350 | 30 | 144 | 4500 | 3.000 | 8547.41 | 1.2984 | 922214.8 | 614809.9 | 5336.9 | 5400 |
| 1300 | 30 | 144 | 4500 | 3.000 | 8397.50 | 1.2606 | 907696.7 | 605131.2 | 5252.9 | 5200 |
| 1200 | 30 | 144 | 4500 | 3.000 | 8097.70 | 1.1872 | 878576.9 | 585717.9 | 5084.4 | 4800 |
| 1100 | 30 | 144 | 4500 | 3.000 | 7797.89 | 1.1109 | 849341.6 | 566227.7 | 4915.2 | 4400 |
| 1000 | 30 | 144 | 4500 | 3.000 | 7498.08 | 1.0317 | 819986.1 | 546657.4 | 4745.3 | 4000 |
| 900 | 30 | 144 | 4500 | 3.000 | 7198.27 | 0.9493 | 790505.2 | 527003.5 | 4574.7 | 3600 |
| 800 | 30 | 144 | 4500 | 3.000 | 6898.46 | 0.8633 | 760893.4 | 507262.2 | 4403.3 | 3200 |
| 700 | 30 | 144 | 4500 | 3.000 | 6598.66 | 0.7735 | 731144.4 | 487429.6 | 4231.2 | 2800 |
| 600 | 30 | 144 | 4500 | 3.000 | 6298.85 | 0.6795 | 701251.6 | 467501.1 | 4058.2 | 2400 |
| 500 | 30 | 144 | 4500 | 3.000 | 5999.04 | 0.5810 | 671207.6 | 447471.7 | 3884.3 | 2000 |
| 400 | 30 | 144 | 4500 | 3.000 | 5699.23 | 0.4774 | 641004.2 | 427336.1 | 3709.5 | 1600 |
| 300 | 30 | 144 | 4500 | 3.000 | 5399.42 | 0.3682 | 610632.5 | 407088.3 | 3533.8 | 1200 |
| 200 | 30 | 144 | 4500 | 3.000 | 5099.62 | 0.2528 | 580082.3 | 386721.5 | 3357.0 | 800 |
| 100 | 30 | 144 | 4500 | 3.000 | 4799.81 | 0.1303 | 549342.4 | 366228.3 | 3179.1 | 400 |
| 0 | 30 | 144 | 4500 | 3.000 | 4500.00 | 0.0000 | 518400.0 | 345600.0 | 3000.0 | 0 |
| 1350 | 40 | 144 | 800 | 4.599 | 7004.55 | 1.9679 | 730132.0 | 486754.6 | 4225.3 | 5400 |
| 1300 | 40 | 144 | 800 | 4.599 | 6774.76 | 1.9376 | 707282.3 | 471521.5 | 4093.1 | 5200 |
| 1200 | 40 | 144 | 800 | 4.599 | 6315.16 | 1.8739 | 661471.0 | 440980.7 | 3828.0 | 4800 |
| 1100 | 40 | 144 | 800 | 4.599 | 5855.56 | 1.8054 | 615501.0 | 410334.0 | 3561.9 | 4400 |
| 1000 | 40 | 144 | 800 | 4.599 | 5395.97 | 1.7312 | 569359.5 | 379573.0 | 3294.9 | 4000 |
| 900 | 40 | 144 | 800 | 4.599 | 4936.37 | 1.6505 | 523031.1 | 348687.4 | 3026.8 | 3600 |
| 800 | 40 | 144 | 800 | 4.599 | 4476.77 | 1.5619 | 476498.0 | 317665.3 | 2757.5 | 3200 |
| 700 | 40 | 144 | 800 | 4.599 | 4017.18 | 1.4636 | 429738.3 | 286492.2 | 2486.9 | 2800 |
| 600 | 40 | 144 | 800 | 4.599 | 3557.58 | 1.3534 | 382724.9 | 255149.9 | 2214.8 | 2400 |
| 500 | 40 | 144 | 800 | 4.599 | 3097.98 | 1.2280 | 335423.9 | 223616.0 | 1941.1 | 2000 |
| 400 | 40 | 144 | 800 | 4.599 | 2638.39 | 1.0823 | 287790.8 | 191860.5 | 1665.5 | 1600 |
| 300 | 40 | 144 | 800 | 4.599 | 2178.79 | 0.9087 | 239765.1 | 159843.4 | 1387.5 | 1200 |
| 200 | 40 | 144 | 800 | 4.599 | 1719.19 | 0.6938 | 191259.7 | 127506.5 | 1106.8 | 800 |
| 100 | 40 | 144 | 800 | 4.599 | 1259.60 | 0.4117 | 142138.9 | 94759.3 | 822.6 | 400 |
| 0 | 40 | 144 | 800 | 4.599 | 800.00 | 0.0000 | 92160.0 | 61440.0 | 533.3 | 0 |
| 1350 | 40 | 144 | 4500 | 4.599 | 10704.55 | 0.7860 | 1185337.1 | 790224.8 | 6859.6 | 5400 |
| 1300 | 40 | 144 | 4500 | 4.599 | 10474.76 | 0.7663 | 1161047.9 | 774031.9 | 6719.0 | 5200 |
| 1200 | 40 | 144 | 4500 | 4.599 | 10015.16 | 0.7256 | 1112394.3 | 741596.2 | 6437.5 | 4800 |
| 1100 | 40 | 144 | 4500 | 4.599 | 9555.56 | 0.6830 | 1063636.4 | 709091.0 | 6155.3 | 4400 |
| 1000 | 40 | 144 | 4500 | 4.599 | 9095.97 | 0.6383 | 1014769.2 | 676512.8 | 5872.5 | 4000 |
| 900 | 40 | 144 | 4500 | 4.599 | 8636.37 | 0.5913 | 965786.8 | 643857.9 | 5589.0 | 3600 |
| 800 | 40 | 144 | 4500 | 4.599 | 8176.77 | 0.5417 | 916682.9 | 611122.0 | 5304.9 | 3200 |
| 700 | 40 | 144 | 4500 | 4.599 | 7717.18 | 0.4892 | 867450.6 | 578300.4 | 5020.0 | 2800 |
| 600 | 40 | 144 | 4500 | 4.599 | 7257.58 | 0.4335 | 818081.8 | 545387.9 | 4734.3 | 2400 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 40 | 144 | 4500 | 4.599 | 6797.98 | 0.3742 | 768567.7 | 512378.5 | 4447.7 | 2000 |
| 400 | 40 | 144 | 4500 | 4.599 | 6338.39 | 0.3107 | 718898.1 | 479265.4 | 4160.3 | 1600 |
| 300 | 40 | 144 | 4500 | 4.599 | 5878.79 | 0.2424 | 669061.2 | 446040.8 | 3871.9 | 1200 |
| 200 | 40 | 144 | 4500 | 4.599 | 5419.19 | 0.1686 | 619043.7 | 412695.8 | 3582.4 | 800 |
| 100 | 40 | 144 | 4500 | 4.599 | 4959.60 | 0.0882 | 568829.6 | 379219.7 | 3291.8 | 400 |
| 0 | 40 | 144 | 4500 | 4.599 | 4500.00 | 0.0000 | 518400.0 | 345600.0 | 3000.0 | 0 |

| OVERBURDEN | ANGLE OF INTERNAL FRICTION | OVERBURDEN DENSITY | CONFINING STRESS | TAN B | MAXIMUM STABLE VERT STRESS | DISTANCE TO MAX VERT STRESS | 60 x 60 LOAD CARRY CAPACITY | DESIGN LOAD CAPACITY | DESIGN STRESS | NORMAL STRESS PILLAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FEET | DEGREE | LB/FT3 | PSI | | PSI | FEET | TONS | TONS | PSI | PSI | |
| 1350 | 30 | 144 | 800 | 3.000 | 4847.41 | 3.6405 | 1110145.0 | 740096.7 | 2855.3 | 2400.0 | 1350 |
| 1300 | 30 | 144 | 800 | 3.000 | 4697.50 | 3.5770 | 1078183.9 | 718789.3 | 2773.1 | 2311.1 | 60x60 |
| 1200 | 30 | 144 | 800 | 3.000 | 4397.70 | 3.4438 | 1014039.8 | 676026.6 | 2608.1 | 2133.3 | |
| 1100 | 30 | 144 | 800 | 3.000 | 4097.89 | 3.3011 | 949582.0 | 633054.6 | 2442.3 | 1955.6 | |
| 1000 | 30 | 144 | 800 | 3.000 | 3798.08 | 3.1476 | 884786.1 | 589857.4 | 2275.7 | 1777.8 | |
| 900 | 30 | 144 | 800 | 3.000 | 3498.27 | 2.9814 | 819624.1 | 546416.1 | 2108.1 | 1600.0 | |
| 800 | 30 | 144 | 800 | 3.000 | 3198.46 | 2.8004 | 754062.8 | 502708.6 | 1939.5 | 1422.2 | |
| 700 | 30 | 144 | 800 | 3.000 | 2898.66 | 2.6015 | 688062.8 | 458708.5 | 1769.7 | 1244.4 | |
| 600 | 30 | 144 | 800 | 3.000 | 2598.85 | 2.3808 | 621576.0 | 414384.0 | 1598.7 | 1066.7 | |
| 500 | 30 | 144 | 800 | 3.000 | 2299.04 | 2.1331 | 554543.2 | 369695.5 | 1426.3 | 888.9 | |
| 400 | 30 | 144 | 800 | 3.000 | 1999.23 | 1.8508 | 486888.9 | 324592.6 | 1252.3 | 711.1 | |
| 300 | 30 | 144 | 800 | 3.000 | 1699.42 | 1.5225 | 418514.2 | 279009.5 | 1076.4 | 533.3 | |
| 200 | 30 | 144 | 800 | 3.000 | 1399.62 | 1.1303 | 349284.1 | 232856.0 | 898.4 | 355.6 | |
| 100 | 30 | 144 | 800 | 3.000 | 1099.81 | 0.6432 | 279002.4 | 186001.6 | 717.6 | 177.8 | |
| 0 | 30 | 144 | 800 | 3.000 | 800.00 | 0.0000 | 207360.0 | 138240.0 | 533.3 | 0.0 | |
| 1350 | 30 | 144 | 4500 | 3.000 | 8547.41 | 1.2964 | 2121128.7 | ********* | 5455.6 | 2400.0 | |
| 1300 | 30 | 144 | 4500 | 3.000 | 8397.50 | 1.2606 | 2086448.9 | ********* | 5366.4 | 2311.1 | |
| 1200 | 30 | 144 | 4500 | 3.000 | 8097.70 | 1.1872 | 2016958.4 | ********* | 5187.7 | 2133.3 | |
| 1100 | 30 | 144 | 4500 | 3.000 | 7797.89 | 1.1109 | 1947287.9 | ********* | 5008.5 | 1955.6 | |
| 1000 | 30 | 144 | 4500 | 3.000 | 7498.08 | 1.0317 | 1877430.1 | ********* | 4828.8 | 1777.8 | |
| 900 | 30 | 144 | 4500 | 3.000 | 7198.27 | 0.9493 | 1807377.2 | ********* | 4648.6 | 1600.0 | |
| 800 | 30 | 144 | 4500 | 3.000 | 6898.46 | 0.8633 | 1737120.6 | ********* | 4467.9 | 1422.2 | |
| 700 | 30 | 144 | 4500 | 3.000 | 6598.66 | 0.7735 | 1666651.0 | ********* | 4286.7 | 1244.4 | |
| 600 | 30 | 144 | 4500 | 3.000 | 6298.85 | 0.6795 | 1595958.2 | ********* | 4104.8 | 1066.7 | |
| 500 | 30 | 144 | 4500 | 3.000 | 5999.04 | 0.5810 | 1525031.2 | ********* | 3922.4 | 888.9 | |
| 400 | 30 | 144 | 4500 | 3.000 | 5699.23 | 0.4774 | 1453857.6 | 969238.4 | 3739.3 | 711.1 | |
| 300 | 30 | 144 | 4500 | 3.000 | 5399.42 | 0.3682 | 1382423.8 | 921615.8 | 3555.6 | 533.3 | |
| 200 | 30 | 144 | 4500 | 3.000 | 5099.62 | 0.2528 | 1310714.6 | 873809.7 | 3371.2 | 355.6 | |
| 100 | 30 | 144 | 4500 | 3.000 | 4799.81 | 0.1303 | 1238713.1 | 825808.7 | 3186.0 | 177.8 | |
| 0 | 30 | 144 | 4500 | 3.000 | 4500.00 | 0.0000 | 1166400.0 | 777600.0 | 3000.0 | 0.0 | |
| 1350 | 40 | 144 | 800 | 4.599 | 7004.55 | 1.9679 | 1699089.5 | ********* | 4370.1 | 2400.0 | |
| 1300 | 40 | 144 | 800 | 4.599 | 6774.76 | 1.9376 | 1645041.5 | ********* | 4231.1 | 2311.1 | |
| 1200 | 40 | 144 | 800 | 4.599 | 6315.16 | 1.8739 | 1536771.9 | ********* | 3952.6 | 2133.3 | |
| 1100 | 40 | 144 | 800 | 4.599 | 5855.56 | 1.8054 | 1428256.1 | 952170.7 | 3673.5 | 1955.6 | |
| 1000 | 40 | 144 | 800 | 4.599 | 5395.97 | 1.7312 | 1319474.4 | 879649.6 | 3393.7 | 1777.8 | |
| 900 | 40 | 144 | 800 | 4.599 | 4936.37 | 1.6505 | 1210403.6 | 806935.7 | 3113.2 | 1600.0 | |
| 800 | 40 | 144 | 800 | 4.599 | 4476.77 | 1.5619 | 1101016.0 | 734010.7 | 2831.8 | 1422.2 | |
| 700 | 40 | 144 | 800 | 4.599 | 4017.18 | 1.4636 | 991278.4 | 660852.2 | 2549.6 | 1244.4 | |
| 600 | 40 | 144 | 800 | 4.599 | 3557.58 | 1.3534 | 881149.5 | 587433.0 | 2266.3 | 1066.7 | |
| 500 | 40 | 144 | 800 | 4.599 | 3097.98 | 1.2280 | 770577.4 | 513718.3 | 1981.9 | 888.9 | |
| 400 | 40 | 144 | 800 | 4.599 | 2638.39 | 1.0823 | 659494.5 | 439663.0 | 1696.2 | 711.1 | |
| 300 | 40 | 144 | 800 | 4.599 | 2178.79 | 0.9087 | 547808.7 | 365205.8 | 1409.0 | 533.3 | |
| 200 | 40 | 144 | 800 | 4.599 | 1719.19 | 0.6938 | 435388.2 | 290258.8 | 1119.8 | 355.6 | |
| 100 | 40 | 144 | 800 | 4.599 | 1259.60 | 0.4117 | 322027.3 | 214684.9 | 828.3 | 177.8 | |
| 0 | 40 | 144 | 800 | 4.599 | 800.00 | 0.0000 | 207360.0 | 138240.0 | 533.3 | 0.0 | |
| 1350 | 40 | 144 | 4500 | 4.599 | 10704.55 | 0.7860 | 2702561.8 | ********* | 6951.0 | 2400.0 | |
| 1300 | 40 | 144 | 4500 | 4.599 | 10474.76 | 0.7663 | 2646295.6 | ********* | 6806.3 | 2311.1 | |
| 1200 | 40 | 144 | 4500 | 4.599 | 10015.16 | 0.7256 | 2533648.1 | ********* | 6516.6 | 2133.3 | |
| 1100 | 40 | 144 | 4500 | 4.599 | 9555.56 | 0.6830 | 2420841.3 | ********* | 6226.4 | 1955.6 | |
| 1000 | 40 | 144 | 4500 | 4.599 | 9095.97 | 0.6383 | 2307867.4 | ********* | 5935.9 | 1777.8 | |
| 900 | 40 | 144 | 4500 | 4.599 | 8636.37 | 0.5913 | 2194717.6 | ********* | 5644.8 | 1600.0 | |
| 800 | 40 | 144 | 4500 | 4.599 | 8176.77 | 0.5417 | 2081382.5 | ********* | 5353.3 | 1422.2 | |
| 700 | 40 | 144 | 4500 | 4.599 | 7717.18 | 0.4892 | 1967851.3 | ********* | 5061.3 | 1244.4 | |
| 600 | 40 | 144 | 4500 | 4.599 | 7257.58 | 0.4335 | 1854112.2 | ********* | 4768.8 | 1066.7 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 500 | 40 | 144 | 4500 | 4.599 | 6797.98 | 0.3742 | 1740151.6 | ********* | 4475.7 | 888.9 |
| 400 | 40 | 144 | 4500 | 4.599 | 6338.39 | 0.3107 | 1622954.3 | ********* | 4182.0 | 711.1 |
| 300 | 40 | 144 | 4500 | 4.599 | 5878.79 | 0.2424 | 1511502.7 | ********* | 3887.6 | 533.3 |
| 200 | 40 | 144 | 4500 | 4.599 | 5419.19 | 0.1686 | 1396776.4 | 931184.3 | 3592.5 | 355.6 |
| 100 | 40 | 144 | 4500 | 4.599 | 4959.60 | 0.0882 | 1281751.6 | 854501.1 | 3296.7 | 177.8 |
| 0 | 40 | 144 | 4500 | 4.599 | 4500.00 | 0.0000 | 1166400.0 | 777600.0 | 3000.0 | 0.0 |

$L$ = LOAD CAPACITY PILLAR

$$= (7.2\times10^{-2})(\hat{\sigma}_v)\left[\text{WIDTH}^2 - 2(\text{WIDTH})(\hat{Y}) + 4/3(\hat{Y})^2\right] \quad \text{TONS}$$

EXHIBIT 3

STRENGTH OF COAL, HIAWATHA SEAM
Laboratory Samples, Approximately 2H:1D
By Skelley, Walgamott, Wang

SAMPLES

| Sample no. | Length in mm | Diam. in mm | Uniaxial Stress MPa | Uniaxial Stress PSI | Equivalent Uni.Stress PSI 40x40x7 | FS=1.5 PSI 40x40x7 | Equivalent Uni.Stress PSI 47x47x7 | FS=1.5 PSI 47x47x7 | Equivalent Uni.Stress PSI 60x60x7 | FS=1.5 PSI 60x60x7 | Equivalent Uni.Stress PSI 50x50x7 | FS=1.5 PSI 50x50x7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. 1 | 163.4 | 75.3 | 6.74 | 977.6 | 2272.7 | 1515.1 | 2519.2 | 1679.5 | 2977.0 | 1984.7 | 2624.8 | 1749.9 |
| No. 2 | 180.6 | 75.4 | 5.89 | 854.3 | 2008.0 | 1338.7 | 2225.8 | 1483.9 | 2630.3 | 1753.5 | 2319.2 | 1546.1 |
| No. 3 | 158.8 | 75.5 | 11.00 | 1595.4 | 3695.5 | 2463.7 | 4096.3 | 2730.9 | 4840.8 | 3227.2 | 4268.1 | 2845.4 |
| Average | | | 7.88 | 1142.9 | 2658.7 | 1772.5 | 2947.1 | 1964.7 | 3482.7 | 2321.8 | 3070.7 | 2047.1 |
| Recommend | 150.0 | 75.0 | 10.00 | 1450.4 | 3338.9 | 2225.9 | 3701.1 | 2467.4 | 4373.7 | 2915.8 | 3856.3 | 2570.9 |
| Permit | | | | 3000.0 | 3000.0 | 2000.0 | 3000.0 | 2000.0 | 3000.0 | 2000.0 | 3000.0 | 2000.0 |

| ACTUAL STRESS PSI 40x40 | ACTUAL STRESS PSI 47x47 | ACTUAL STRESS PSI 60x60 | OVERBURDEN FEET | ACTUAL STRESS PSI 50x50 |
|---|---|---|---|---|
| 5400 | 3911.3 | 2400.0 | 1350 | 3456 |
| 5200 | 3766.4 | 2311.1 | 1300 | 3328 |
| 4800 | 3476.7 | 2133.3 | 1200 | 3072 |
| 4400 | 3187.0 | 1955.6 | 1100 | 2816 |
| 4000 | 2897.2 | 1777.8 | 1000 | 2560 |
| 3600 | 2607.5 | 1600.0 | 900 | 2304 |
| 3200 | 2317.8 | 1422.2 | 800 | 2048 |
| 2800 | 2028.1 | 1244.4 | 700 | 1792 |
| 2400 | 1738.3 | 1066.7 | 600 | 1536 |
| 2000 | 1448.6 | 888.9 | 500 | 1280 |
| 1600 | 1158.9 | 711.1 | 400 | 1024 |
| 1200 | 869.2 | 533.3 | 300 | 768 |
| 800 | 579.4 | 355.6 | 200 | 512 |
| 400 | 289.7 | 177.8 | 100 | 256 |
| 0 | 0.0 | 0.0 | 0 | 0 |

$$\sigma_{\frac{\text{PILL WIDTH}}{\text{PILL HEIGHT}}} = \sigma_{\frac{\text{DIA CORE}}{\text{LEN CORE}}} \left( \frac{0.778 + .222 \left( \frac{\text{PILL WIDTH}}{\text{PILL HEIGHT}} \right)}{0.778 + .222 \left( \frac{\text{DIA CORE}}{\text{LEN CORE}} \right)} \right)$$

PILLAR HEIGHT = 7 FT.

FACTOR OF SAFETY = 1.5

ADVANCE 80FT x 80FT

ENTRY 20FT

EXHIBIT 4

| PILLAR WIDTH | PILLAR LENGTH | OVERBURDEN | MIN PILLAR WIDTH | OVB DENSITY | LOAD CARRY CAPACITY | DESIGN LOAD CAPACITY | DESIGN STRESS | NORMAL STRESS PILLAR | |
|---|---|---|---|---|---|---|---|---|---|
| FEET | FEET | FEET | FEET | TONS/FT3 | TONS | TONS | PSI | PSI | |
| 40 | 40 | 1350 | 28.4 | 0.072 | 285343.2 | | 2476.9 | 5400.0 | |
| 40 | 40 | 1300 | 27.3 | 0.072 | 283207.4 | | 2458.4 | 5200.0 | |
| 40 | 40 | 1200 | 25.2 | 0.072 | 277751.8 | | 2411.0 | 4800.0 | |
| 40 | 40 | 1100 | 23.1 | 0.072 | 270506.0 | | 2348.1 | 4400.0 | |
| 40 | 40 | 1000 | 21.0 | 0.072 | 261216.0 | | 2267.5 | 4000.0 | |
| 40 | 40 | 900 | 18.9 | 0.072 | 249627.7 | | 2166.9 | 3600.0 | |
| 40 | 40 | 800 | 16.8 | 0.072 | 235487.2 | | 2044.2 | 3200.0 | |
| 40 | 40 | 700 | 14.7 | 0.072 | 218540.4 | | 1897.1 | 2800.0 | |
| 40 | 40 | 600 | 12.6 | 0.072 | 198533.4 | | 1723.4 | 2400.0 | |
| 40 | 40 | 500 | 10.5 | 0.072 | 175212.0 | | 1520.9 | 2000.0 | |
| 40 | 40 | 400 | 8.4 | 0.072 | 148322.3 | | 1287.5 | 1600.0 | |
| 40 | 40 | 300 | 6.3 | 0.072 | 117610.3 | | 1020.9 | 1200.0 | |
| 40 | 40 | 200 | 4.2 | 0.072 | 82821.9 | | 718.9 | 800.0 | |
| 40 | 40 | 100 | 2.1 | 0.072 | 43703.1 | | 379.4 | 400.0 | |
| 40 | 40 | 0 | 0.0 | 0.072 | 0.0 | | 0.0 | 0.0 | |
| 60 | 60 | 1350 | 28.4 | 0.072 | 842493.6 | | 3250.4 | 2400.0 | – 1350 |
| 60 | 60 | 1300 | 27.3 | 0.072 | 827585.0 | | 3192.8 | 2311.1 | |
| 60 | 60 | 1200 | 25.2 | 0.072 | 794769.4 | | 3066.2 | 2133.3 | |
| 60 | 60 | 1100 | 23.1 | 0.072 | 757744.4 | | 2923.4 | 1955.6 | |
| 60 | 60 | 1000 | 21.0 | 0.072 | 716256.0 | | 2763.3 | 1777.8 | |
| 60 | 60 | 900 | 18.9 | 0.072 | 670050.1 | | 2585.1 | 1600.0 | |
| 60 | 60 | 800 | 16.8 | 0.072 | 618872.8 | | 2387.6 | 1422.2 | |
| 60 | 60 | 700 | 14.7 | 0.072 | 562470.0 | | 2170.0 | 1244.4 | |
| 60 | 60 | 600 | 12.6 | 0.072 | 500587.8 | | 1931.3 | 1066.7 | |
| 60 | 60 | 500 | 10.5 | 0.072 | 432972.0 | | 1670.4 | 888.9 | |
| 60 | 60 | 400 | 8.4 | 0.072 | 359368.7 | | 1386.5 | 711.1 | |
| 60 | 60 | 300 | 6.3 | 0.072 | 279523.9 | | 1078.4 | 533.3 | |
| 60 | 60 | 200 | 4.2 | 0.072 | 193183.5 | | 745.3 | 355.6 | |
| 60 | 60 | 100 | 2.1 | 0.072 | 100093.5 | | 386.2 | 177.8 | |
| 60 | 60 | 0 | 0.0 | 0.072 | 0.0 | | 0.0 | 0.0 | |
| 40 | 60 | 1350 | 28.4 | 0.072 | 486158.4 | | 2813.4 | 3600.0 | |
| 40 | 60 | 1300 | 27.3 | 0.072 | 480516.2 | | 2780.8 | 3466.7 | |
| 40 | 60 | 1200 | 25.2 | 0.072 | 467140.6 | | 2703.4 | 3200.0 | |
| 40 | 60 | 1100 | 23.1 | 0.072 | 450765.2 | | 2608.6 | 2933.3 | |
| 40 | 60 | 1000 | 21.0 | 0.072 | 431136.0 | | 2495.0 | 2666.7 | |
| 40 | 60 | 900 | 18.9 | 0.072 | 407998.9 | | 2361.1 | 2400.0 | |
| 40 | 60 | 800 | 16.8 | 0.072 | 381100.0 | | 2205.4 | 2133.3 | – 800 |
| 40 | 60 | 700 | 14.7 | 0.072 | 350185.2 | | 2026.5 | 1866.7 | |
| 40 | 60 | 600 | 12.6 | 0.072 | 315000.6 | | 1822.9 | 1600.0 | |
| 40 | 60 | 500 | 10.5 | 0.072 | 275292.0 | | 1593.1 | 1333.3 | |
| 40 | 60 | 400 | 8.4 | 0.072 | 230805.5 | | 1335.7 | 1066.7 | |
| 40 | 60 | 300 | 6.3 | 0.072 | 181287.1 | | 1049.1 | 800.0 | |
| 40 | 60 | 200 | 4.2 | 0.072 | 126482.7 | | 732.0 | 533.3 | |
| 40 | 60 | 100 | 2.1 | 0.072 | 66138.3 | | 382.7 | 266.7 | |
| 40 | 60 | 0 | 0.0 | 0.072 | 0.0 | | 0.0 | 0.0 | |

WILSON, ASHWIN

PILLAR WIDTH $\geq (.003)(\text{COAL HEIGHT})(\text{OVB})$

SQUARE LOAD $= (4)(.072 \text{ TON/FT}^3)(W_p^2 - 3V_p h H 10^{-3} + 3h^2H^2 10^{-6})$ TONS

RECT. LOAD $= (4)(.072)(h)(W_p L_p - 1.5(W_p - L_p)hH 10^{-3} + 3h^2H^2 10^{-6})$ TONS

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

APPENDIX 5-11-2

COLLECTION AGREEMENT – SUBSIDENCE

# APPENDIX 11-2

# COLLECTION AGREEMENT

United States Department of Agriculture
Forest Service
Manti-LaSal National Forest
599 West Price River Drive
Price, Utah 84501

Reply to: 2820
7140
Date: July 11, 1984

Mr. Alan Childs
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537

Dear Mr. Childs:

Enclosed is your copy of the Collection Agreement between Trail Mountain Coal Company and the Manti-LaSal National Forest, regarding subsidence monitoring.

Sincerely,

W. H. Bailey
for
REED C. CHRISTENSEN
Forest Supervisor

Enclosure

COLLECTION AGREEMENT

Between

Trail Mountain Coal Company

And

Manti-LaSal National Forest
United States Department of Agriculture

THIS COLLECTION AGREEMENT, made and entered into by and between Trail Mountain Coal Company, hereinafter referred to as the DEPOSITOR, and the Manti-LaSal National Forest, U.S. Department of Agriculture, hereinafter referred to as the FOREST SERVICE, under the provisions of the Granger--Thye Act of February 24, 1950 (16 U.S.C. 572).

WITNESSETH:

WHEREAS, the FOREST SERVICE has the responsibility as a surface management agency to insure mineral development with adequate protection of surface resources,

WHEREAS, the DEPOSITOR is desirous to comply with the requirements for subsidence monitoring (30 CFR 211-700),

WHEREAS, it is to the mutual advantage of the parties hereto mentioned to cooperate in instigating and supporting a photogrammetric method of monitoring subsidence, more particularly prescribed in the attached plan, which is hereby made part of this agreement.

NOW THEREFORE, in consideration of the above premises, the parties hereto agree as follows:

A. THE DEPOSITOR SHALL

1. Construct target monuments at designated locations over their lease area. One of these must be at or near the mine portal. These target monuments shall be in accordance with or superior to those shown on Attachment No. 1.

2. Determine the precise coordinates and elevation of each of these monuments--Utah Coordinate System should be used.

3. Target all monuments, as shown on Attachment No. 1, for the first year, and as specified by the FOREST SERVICE each successive year prior to taking of the aerial photography.

4. Provide the FOREST SERVICE with copies of the survey data.

5. Upon presentation of a Bill for Collection, annually deposit with the FOREST SERVICE, within 30 days, the amount estimated by the FOREST SERVICE, needed to cover the cost of conducting the annual aerial photographic survey of portions of the leasehold. This amount includes the cost of conducting the aerial survey, color and infrared photography, prints (digitizing photographs, producing contour maps, and/or ortho photographs, as needed), and related indirect costs.

6. Upon presentation of a Bill for Collection, reimburse the FOREST SERVICE within 60 days the actual cost of services in excess of advance deposits.

B. THE FOREST SERVICE SHALL

1. Make aerial photographs of the lease area using methods that will produce usable and adequate photographic prints for measurement of subsidence.

2. Perform aerial triangulation (bridging).

3. Make point readings for subsidence monitoring (as necessary).

4. Provide to the DEPOSITOR one set of black and white and one set of color prints (9" x 9"), with a 1:4800 scale following each annual flight.

5. Provide to the DEPOSITOR copies of all subsidence monitoring point readings (as may be required).

6. Deposit funds so collected in the cooperative work fund of the FOREST SERVICE.

7. Use the funds collected under A.5 and A.6 to cover the costs of conducting aerial surveys, color and (when required and agreed upon) infrared photography, prints, digitizing photographs, and producing contour maps and/or ortho photographs, as needed.

8. Assist, cooperate, and--in some areas--conduct range analysis, timber surveys, and wildlife habitat studies on National Forest System lands, as may be necessary, to determine the effects of undermining upon surface resources.

C. IT IS MUTUALLY AGREED AND UNDERSTOOD BY AND BETWEEN THE SAID PARTIES THAT

1. As data is collected, frequency and times of the surveys may be changed to accommodate identified needs.

2. The FOREST SERVICE will require continuance of programs until such time it is determined the program is no longer needed, but not to exceed five years following final closure of the mine. Special cases may exist which require this time period to extend beyond five years. Concurrence of all involved parties would then be required for extending this monitoring period.

3. This agreement will have no effect on provisions and clauses of any of the DEPOSITOR'S Special Use Permit(s).

4. Upon request of the DEPOSITOR, any unused or unobligated deposited funds for a given year will be refunded, and a statement of costs for the period provided. Otherwise, unused or unobligated funds will be applied to the following year's billing(s).

5. That nothing herein shall be construed as obligating the FOREST SERVICE to expend, or as involving the United States in any contract or other obligation for the future payment of, money in excess of appropriations authorized by law and administratively allocated for this work.

6. No Member of or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall be construed to extend to this agreement if made with a corporation for its general benefit.

7. This agreement may be amended as necessary by mutual consent of both parties, by the issuance of a written amendment, signed and dated by both parties.

8. Either party may terminate the agreement by providing 60 days' written notice: Provided that any funds on deposit will be available for expenses incident to closing out the work beyond the period of written notice. Unless terminated by written notice, this agreement will remain in force indefinitely.

IN WITNESS THEREOF, the parties hereto have executed this agreement as of the last date written below.

TRAIL MOUNTAIN COAL COMPANY

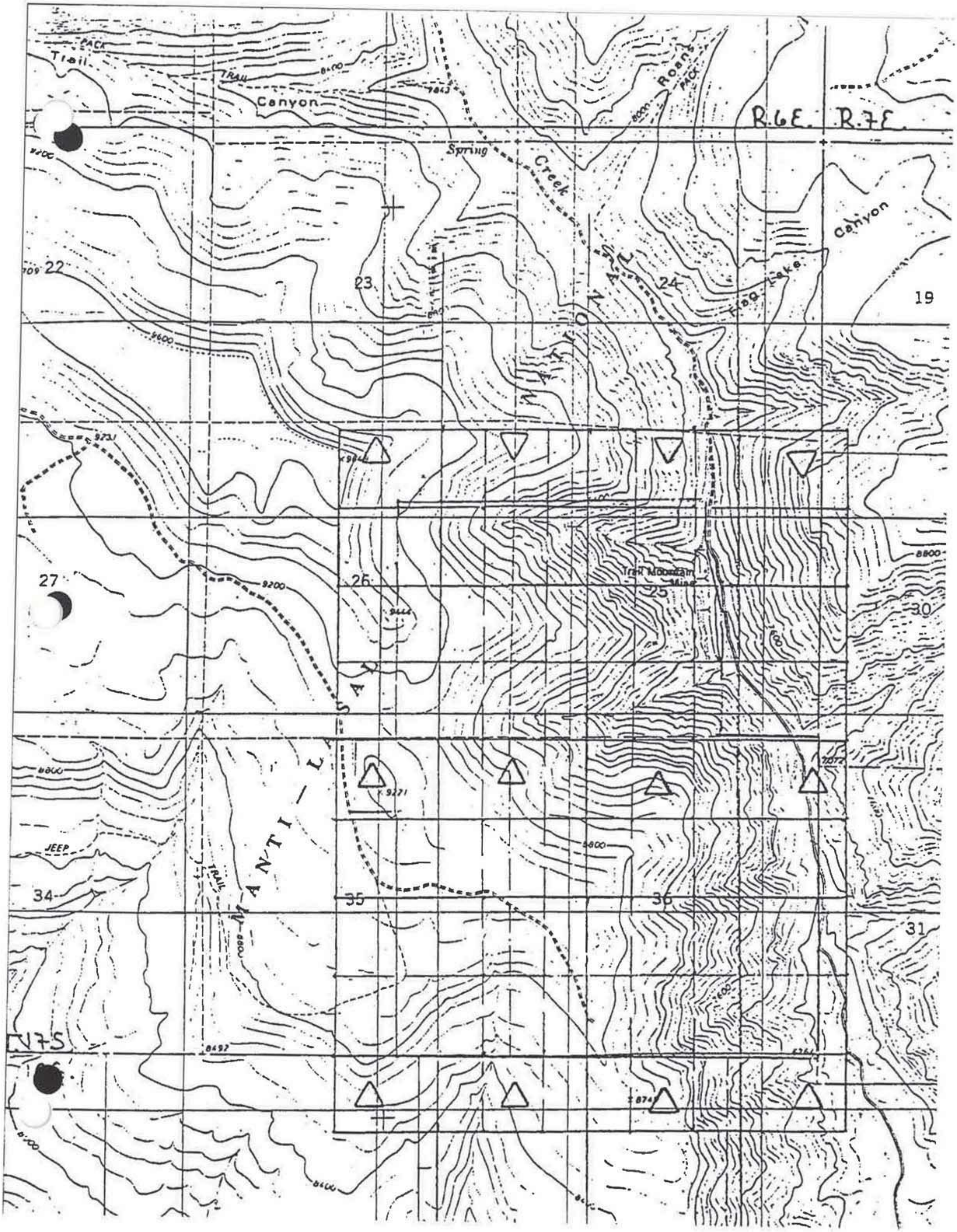
7/3/84
Date

By: Joe Dilder

USDA - FOREST SERVICE

7/10/84
Date

By: Reed C Christensen
Forest Supervisor



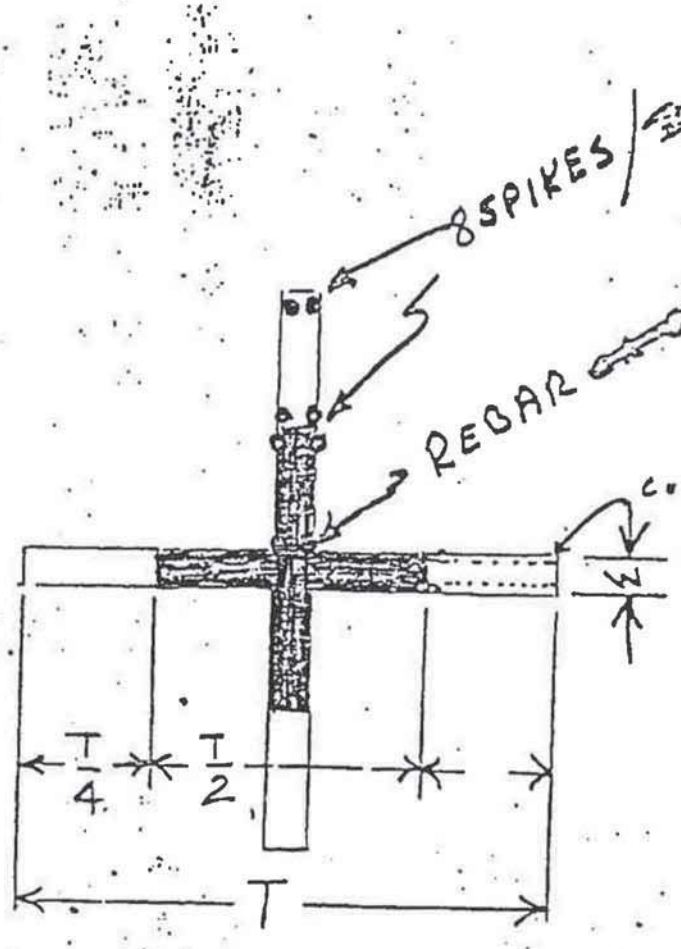
Trail
PACK
TRAIL
Canyon
Roans
PACK
R.6E. R.7E.
Spring
Creek
Canyon
Flag Lake
22
23
24
19
NATIONAL
Trail Mountain Mine
26
25
27
30
9200
9600
8800
9271
JEEP
TRAIL
MANTI-LA SAL
34
35
36
31
T17S
8492
8400

## PHOTOGRAPHIC TARGETS (GROUND PANELS)

The precision required in large scale mapping projects using photogrammetrics methods, requires an exact correlation between the photography coverage and a significant number of selected points or monuments on the ground for which X, Y, and Z coordinates are accurately measured and established by ground survey methods. These points are usually station markers in the ground in solid rock or on a permanent concrete-type structure where the points, once measured, will be well preserved for recovery and use whenever needed. Placement of a target centered on the monument or station marker so it will appear as a well-defined concentric image on the aerial photographs is essential (see Figure 4/3). These targets should also be placed on all supplemental control points required for orientation of the aerial photographs in photogrammetric instruments for forming stereoscopic models to scale and elevation for accomplishing the required measuring and mapping. Targets should also be placed on pertinent survey monuments on the boundaries of all affected properties including Township and Range, Section and quarter corners. Predetermined points on which photogrammetric measurements will be made to establish surface bareline information may also require targeting, however, these will not require permanent monumentation. In this case, capped rebar in the center of each target will be adequate. Property corners not used as basic control may be targeted with only 3 legs of equal spacing using the same dimensions as shown in Figure 3.

Care should be taken where possible to place control and targets in open areas where they will not be obscured by ground cover and/or shadows. In some cases, this may not be possible and clearing will be required. Figure 5/4 illustrates the approximate clearing criteria. Experience has shown that the darker center of the target provides better contact for "readability".

ATTACHMENT 1




FOR 1:4800 PHOTO
T = 8' MINIMUM TO 10' DEPENDING ON SLOPE & ASPECT
W = 6.7" MINIMUM ALLOW ADDITIONAL WIDTH FOR CUFF ON @ SIDE

T = TOTAL LENGTH (IN FEET)
= 1/50 PHOTO SCALE (ft to 1in)
1:6000 PSR = 1" = 500' ÷ 50 = 10' - 12'

W = WIDTH OF LEG IN INCHES
= 1/60 PHOTO SCALE (ft to 1 in)
1:6000 = 1" = 500 ÷ 60 = 8.3" - 12"

GRIFFOLYN TYPE 65 B|W MATTE
1200' ROLLS 50" WIDE

1:6000 $2.13 + / TARGET

* MAINTENANCE & RECORD OF LOCATION

APPENDIX 5-11-3

1984-1986 SUBSIDENCE DATA

# APPENDIX 11-3

# 1984 - 86 SUBSIDENCE DATA

# APPENDIX 12-3

## 1984-86 Subsidence Data
## U.S. Forest Service Based on Aerial Flights

This data will be inserted into the Mine Reclamation Plan when the U.S. Forest Service completes the subsidence data and supplies it to Beaver Creek Coal Company**

APPENDIX 5-11-4

1988 SUBSIDENCE DATA

# APPENDIX 11-4

# 1988 SUBSIDENCE DATA

# 1988

# SUBSIDENCE MONITORING REPORT

# Bruce T. S. Ware

**REGISTERED LAND SURVEYOR**
**RT. 1, BOX 146 H-2 HELPER, UTAH 84526**
**Phone 637-2620**


SUBSIDENCE MONITORING FOR

TRAIL MOUNTAIN #9 MINE



| Station | Original elevation Oct./Nov. 1986 | Survey elev. Oct. 1988 | Change |
|---|---|---|---|
| TMS 5-1W | 8726.49 | 8726.50 | +0.01 |
| TMS 5 | 8667.11 | 8667.15 | +0.04 |
| TMS 5-1E | 8552.84 | 8552.57 | -0.27 |
| TMS 5-2E | 8376.51 | 8376.34 | -0.17 |
| TMS 5-3E | 8254.87 | 8253.56 | -1.31 |
| TMS 5-4E | 8222.28 | 8220.91 | -1.37 |
| TMS 5-5E | 8271.12 | 8269.90 | -1.22 |
| TMS 5-6E | 8282.30 | 8281.02 | -1.28 |
| TMS 5-7E | 8247.31 | 8245.95 | -1.36 |
| TMS 6-9W | 8847.41 | 8847.48 | +0.07 |
| TMS 6-8W | 8777.88 | 8778.91 | +1.03 |
| TMS 6-7W | 8703.52 | 8703.56 | +0.04 |
| TMS 6-6W | 8672.38 | 8672.41 | +0.03 |
| TMS 6-5W | 8624.83 | 8624.56 | -0.27 |
| TMS 6-4W | 8583.89 | 8583.86 | -0.03 |
| TMS 6-3W | 8582.66 | 8582.63 | -0.03 |
| TMS 6-2W | 8541.26 | 8541.24 | -0.02 |
| TMS 6-1W | 8567.21 | 8567.20 | -0.01 |
| TMS 6 | 8585.30 | 8585.30 | 0.00 |
| TMS 3-6W | 9068.96 | 9068.89 | -0.07 |
| TMS 3-5W | 9067.50 | 9067.43 | -0.07 |
| TMS 3-4W | 9009.30 | 9009.18 | -0.12 |
| TMS 3-3W | 8974.95 | 8974.97 | +0.02 |
| TMS 3-2W | 8928.61 | 8928.56 | -0.05 |
| TMS 3-1W | 8924.49 | 8924.45 | -0.04 |
| TMS 3 | 8911.80 | 8911.74 | -0.06 |
| TMS 3-1E | 8803.61 | 8803.58 | -0.03 |
| TMS 3-2E | 8748.89 | 8748.90 | +0.01 |

**Bruce T. S. Ware**
**REGISTERED LAND SURVEYOR**
**RT. 1, BOX 146 H-2 HELPER, UTAH 84526**
**Phone 637-2620**

SUBSIDENCE MONITORING FOR
TRAIL MOUNTAIN #9 MINE



| Station | Original elevation Oct./Nov. 1986 | Survey elev. Oct. 1988 | Change |
|---|---|---|---|
| TMS 2 | 9060.28 | 9060.18 | -0.10 |
| TMS 2-1E | 9058.87 | 9058.68 | -0.19 |
| TMS 2-2E | 9059.33 | 9059.13 | -0.20 |
| TMS 2-3E | 9064.08 | 9063.84 | -0.24 |
| TMS 2-4E | 9070.00 | 9069.78 | -0.22 |
| TMS 2-5E | 9061.85 | 9061.60 | -0.25 |
| TMS 2-6E | 8902.43 | 8902.14 | -0.29 |
| TMS 2-7E | 8745.21 | 8744.74 | -0.47 |
| TMS 2-8E | 8597.74 | 8597.18 | -0.56 |
| TMS 2-9E | 8550.32 | 8549.78 | -0.54 |
| TMS 8-9W | 8914.06 | 8913.91 | -0.15 |
| TMS 8-8W | 8909.33 | 8909.11 | -0.22 |
| TMS 8-7W | 8944.46 | 8944.20 | -0.26 |
| TMS 8-6W | 8979.17 | 8978.97 | -0.20 |
| TMS 8-5W | 9015.60 | 9015.42 | -0.18 |
| TMS 8-4W | 9044.07 | 9043.89 | -0.18 |
| TMS 8-3W | 8994.63 | 8994.50 | -0.13 |
| TMS 8-2W | 8854.62 | 8854.55 | -0.07 |
| TMS 8-1W | 8737.92 | 8737.93 | +0.01 |
| TMS 8 | 8650.46 | 8650.46 | 0.00 |
| 10 W#13 | 8725.32 | 8725.29 | -0.03 |
| 10 W#12 | 8738.03 | 8737.97 | -0.06 |
| 10 W#11 | 8764.34 | 8764.26 | -0.08 |
| 10 W#10 | 8813.32 | 8813.21 | -0.09 |
| 10 W#9 | 8866.54 | 8866.46 | -0.08 |
| 10 W#8 | 8923.85 | 8923.70 | -0.15 |
| 10 W#7 | 8979.89 | LOST | |
| 10 W#6 | 8998.19 | 8998.05 | -0.14 |
| 10 W#5 | 8904.99 | 8904.84 | -0.15 |

**Bruce T. S. Ware**
**REGISTERED LAND SURVEYOR**
**RT. 1, BOX 146 H-2 HELPER, UTAH 84526**
**Phone 637-2620**

SUBSIDENCE MONITORING FOR

TRAIL MOUNTAIN #9 MINE



| Station | Original elevation Oct./Nov. 1986 | Survey elev. Oct. 1988 | Change |
|---|---|---|---|
| 10 W#4 | 8813.19 | 8813.01 | -0.18 |
| 10 W#3 | 8739.89 | 8739.73 | -0.16 |
| 10 W#2 | 8645.90 | 8645.72 | -0.18 |
| 10 W#1 | 8584.66 | 8584.53 | -0.13 |
| 10 W Zero | 8531.07 | 8530.92 | -0.15 |
| 11 W#13 | 8669.84 | 8670.53 | +0.69 |
| 11 W#12 | 8689.23 | 8689.23 | 0.00 |
| 11 W#11 | 8715.02 | 8714.99 | -0.03 |
| 11 W#10 | 8746.50 | 8746.48 | -0.02 |
| 11 W#9 | 8792.97 | 8792.95 | -0.02 |
| 11 W#8 | 8849.92 | 8849.86 | -0.06 |
| 11 W#7 | 8910.03 | 8909.99 | -0.04 |
| 11 W#6 | 8948.37 | 8948.28 | -0.09 |
| 11 W#5 | 8856.84 | 8856.76 | -0.08 |
| 11 W#4 | 8771.36 | 8771.27 | -0.09 |
| 11 W#3 | 8694.92 | 8694.85 | -0.07 |
| 11 W#2 | 8626.37 | 8626.30 | -0.07 |
| 11 W#1 | 8557.82 | 8557.79 | -0.03 |
| 11 W Zero | 8526.88 | 8526.82 | -0.06 |
| 12 W#12 | 8613.12 | 8613.17 | +0.05 |
| 12 W#11 | 8624.55 | 8624.58 | +0.03 |
| 12 W#10 | 8670.28 | 8670.33 | +0.05 |
| 12 W#9 | 8703.86 | 8703.89 | +0.03 |
| 12 W#8 | 8732.75 | 8732.80 | +0.05 |
| 12 W#7 | 8777.98 | 8778.00 | +0.02 |
| 12 W#6 | 8834.96 | 8834.93 | -0.03 |
| 12 W#5 | 8875.09 | 8875.09 | 0.00 |
| 12 W#4 | 8775.49 | 8775.44 | -0.05 |
| 12 W#3 | 8701.58 | 8701.51 | -0.07 |

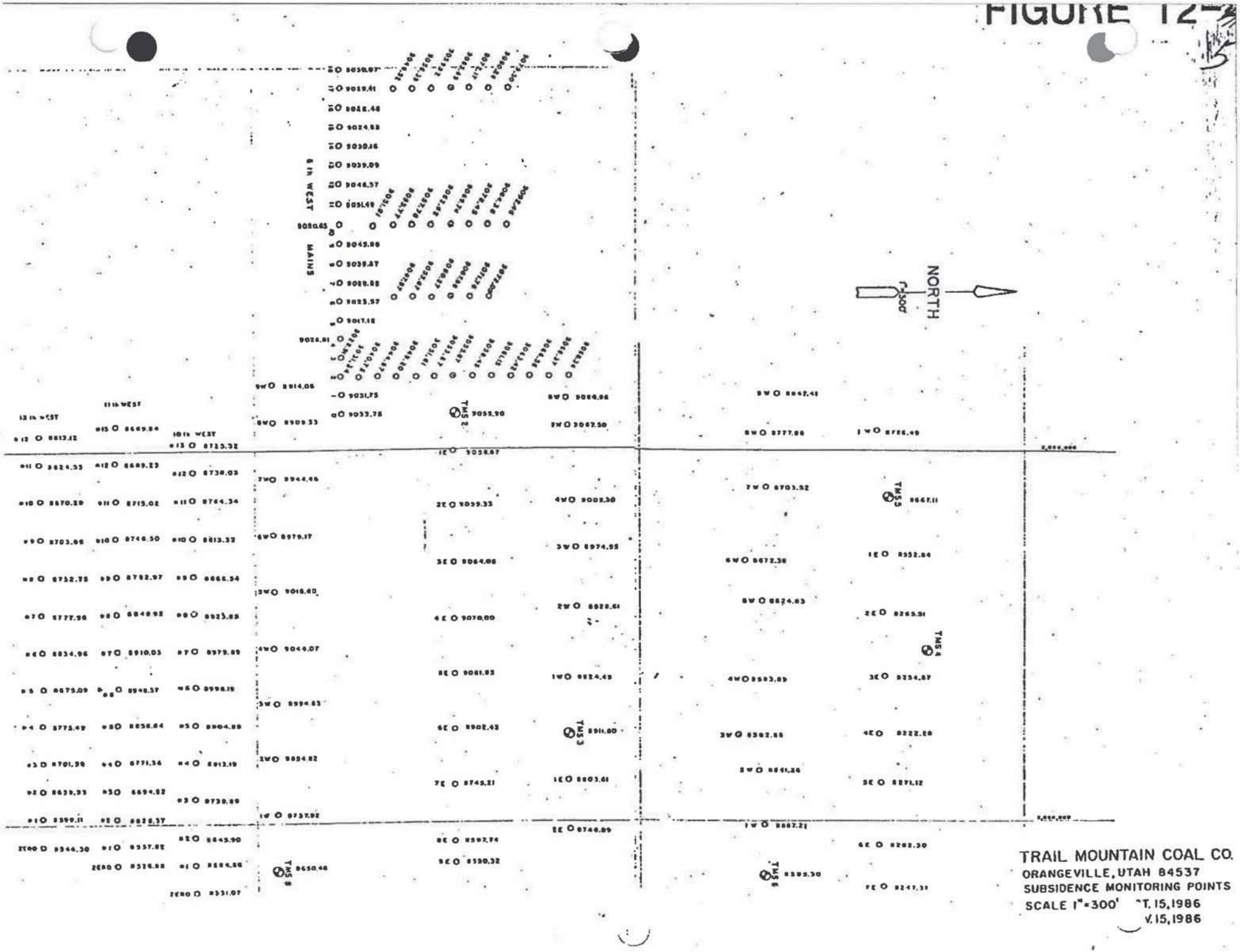
**Bruce T. S. Ware**
REGISTERED LAND SURVEYOR
RT. 1, BOX 146 H-2 HELPER, UTAH 84526
Phone 637-2620

SUBSIDENCE MONITORING FOR
TRAIL MOUNTAIN #9 MINE



| Station | Original elevation Oct./Nov. 1986 | Survey elev. Oct. 1988 | Change |
|---|---|---|---|
| 12 W#2 | 8639.53 | 8639.52 | -0.01 |
| 12 W#1 | 8599.11 | 8599.09 | -0.02 |
| 12 W Zero | 8546.30 | 8546.30 | 0.00 |
| 6 W. Zero | 9033.75 | 9033.54 | -0.21 |
| 6 W#1 | 9031.75 | 9031.57 | -0.18 |
| 6 W#2 | 9031.34 | 9031.17 | -0.17 |
| 6 W#3 | 9028.91 | 9028.79 | -0.12 |
| 6 W#4 | 9026.81 | 9026.69 | -0.12 |
| 6 W#5 | 9017.18 | LOST | |
| 6 W#6 | 9023.57 | 9023.47 | -0.10 |
| 6 W#7 | 9029.52 | 9029.39 | -0.13 |
| 6 W#8 | 9039.87 | 9039.77 | -0.10 |
| 6 W#9 | 9045.88 | 9045.80 | -0.08 |
| 6 W#10 | 9050.65 | 9050.60 | -0.05 |
| 6 W#11 | 9051.49 | 9051.45 | -0.04 |
| 6 W#12 | 9046.57 | 9046.55 | -0.02 |
| 6 W#13 | 9039.09 | 9039.13 | +0.04 |
| 6 W#14 | 9030.16 | 9030.15 | -0.01 |
| 6 W#15 | 9024.83 | 9024.88 | +0.05 |
| 6 W#16 | 9022.48 | 9022.47 | -0.01 |
| 6 W#17 | 9029.41 | 9029.45 | +0.04 |
| 6 W#18 | 9030.07 | 9030.12 | +0.05 |

FIGURE 12


NORTH
MAINS
TMS 1
TMS 2
TMS 3
TMS 4
TMS 5
TMS 6
TRAIL MOUNTAIN COAL CO.
ORANGEVILLE, UTAH 84537
SUBSIDENCE MONITORING POINTS
SCALE 1"=300'
T. 15, 1986
V. 15, 1986

APPENDIX 5-11-5

VERTICAL DISPLACEMENT

# APPENDIX 11-5

# VERTICAL DISPLACEMENT

EarthFax

EarthFax
Engineering Inc.
Engineers/Scientists
7324 South 1300 East
Suite 100
Midvale, Utah 84047
Telephone 801·561-1555

February 4, 1987

Mr. Allen P. Childs
Mine Engineer
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537-0370

Subject: Preliminary observations of subsidence at the Trail Mountain Mine, 1984-1986

Dear Allen:

We have reviewed the subsidence data provided in a transmittal by Mr. William H. Boley dated January 28, 1987 (see Appendix A). These data consist of seven points where elevation measurements were taken in 1984 and again in 1986 (precise dates not provided). The transmittal also contained computed changes in elevation.

Insufficient data were provided to permit a detailed analysis of subsidence in the mine area. Mr. Boley indicated in his transmittal that additional data would be provided at a later date. With these additional data points, contours of subsidence can be prepared and more-detailed conclusions can be drawn. It is anticipated that the additional data will be available in April 1987.

A map showing the location of the subsidence monitoring stations included in Mr. Boley's transmittal and the coinciding changes in ground-surface elevation between 1984 and 1986 is included herewith as Plate 12-5. No springs are known to exist within the area of these measurements. A profile showing elevation changes (from west to east) is provided in Figure 1.

According to Dunrud (1976), both positive and negative changes in elevation are typical expressions of subsidence. Positive changes occurred in the western portion of the study area where the overburden thickness was greatest. Negative changes occurred in the eastern portion of the study area where the overburden thickness was least and where mining was most recently completed. Once again, due to the limited data base, more detailed conclusions cannot be drawn at this time.

A comparison of mine panel width/mean overburden depth ratios to subsidence ratios for the Trail Mountain Mine with similar measurements from other mines reported by Dunrud (1976) indicate that subsidence amounts at the Trail Mountain Mine are typical. These conclusions may be refined as new data become available.

EarthFax

EarthFax
Engineering Inc.
Engineers/Scientists
7324 South 1300 East
Suite 100
Midvale, Utah 84047
Telephone 801·561-1555



Please contact us when the additional data are available from the Forest Service. At that time, we should be able to prepare contour maps and more detailed analyses of subsidence effects at the mine.

Sincerely,

Richard B. White, P.E.
Principal Hydrologist

Enclosure

Reference Cited

Dunrud, C.R. 1976. Some Engineering Geologis Factors Controlling Coal Mine Subsidence in Utah and Colorado. U.S. Geological Survey Professional Paper 969. Washington, D.C.

# APPENDIX A

## Preliminary Subsidence Data as Obtained From the U.S. Forest Service

MESSAGE DISPLAY

TO C.REED

From: William H. Boley
Postmark: Jan 28,87 12:40 PM

Subject: Forwarded: TRAIL MTN. MINE SUBSIDENCE MONITORING (INTERIM PT.READIN

---

Comments:
From William H. Boley:
DON'T REMEMBER IS I FORWARDED THIS TO YOU OR NOT. IF I DID ,NOW
YOU HAVE IT TWICE.

Message:
From LYNN H. WIESE:RO4A:

| N. | E | 84 ELEV. | 86 ELEV. | DIFF. |
|---|---|---|---|---|
| 351,500.09375 | 2,086,000.00781 | 8731.92285 | 8732.18652 | +0.26367 |
| | 200.00000 | 8761.10758 | 8761.99902 | +0.89144 |
| | 399.98438 | 8802.67871 | 8803.01953 | +0.34082 |
| | 600.02344 | 8853.60059 | 8854.08984 | +0.48925 |
| | 2,086,800.00000 | 8907.87988 | 8907.84570 | -0.03418 |
| | 87,000.00000 | 8964.62012 | 8963.77148 | -0.84864 |
| 351,500.18750 | 200.00000 | 8977.04883 | 8976.01367 | -1.03516 |

We have 130 pts. over this panel,will send later if needed. L.Wiese.

---

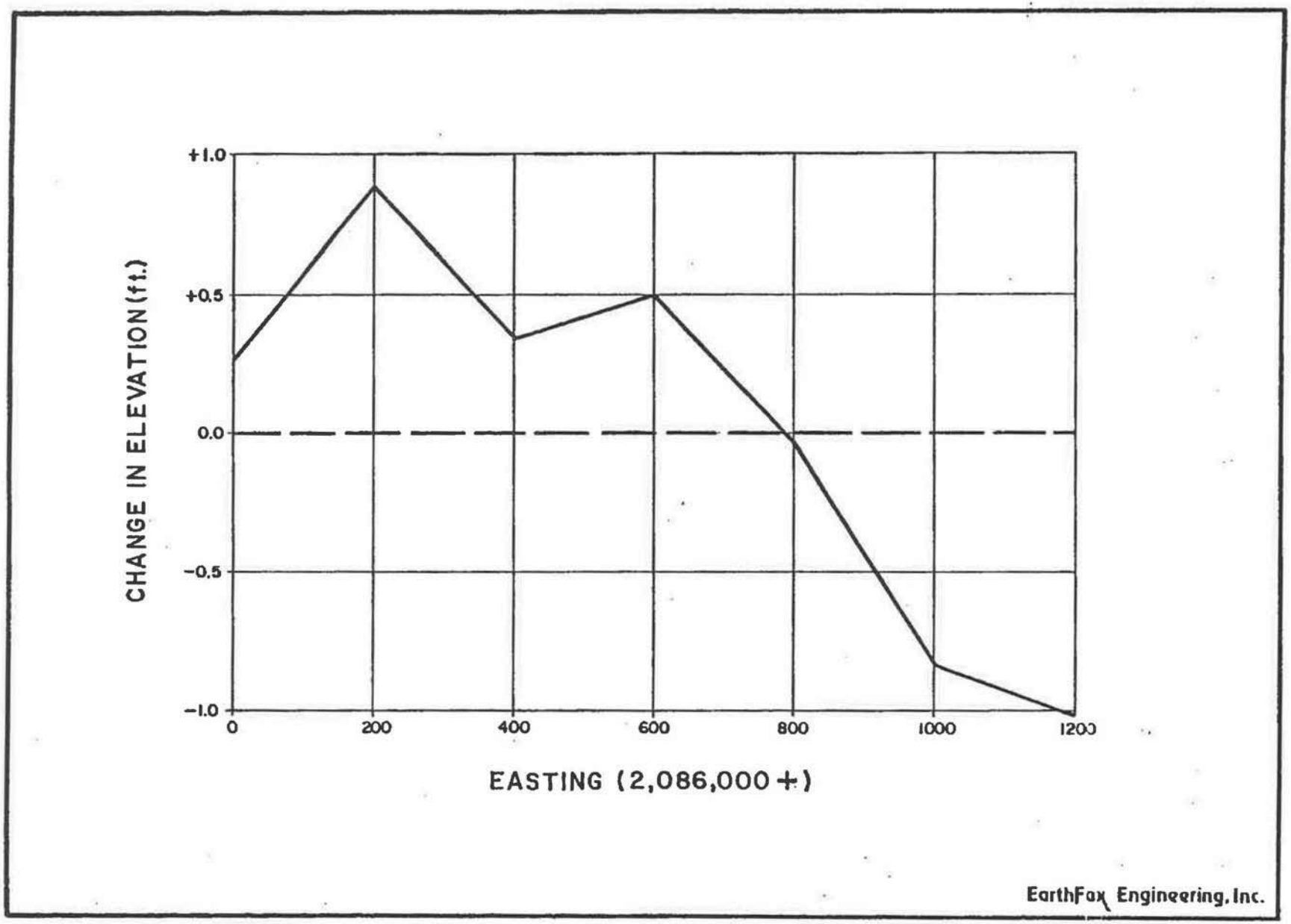



Figure 1. Net change in ground surface elevation above the 10th West mine panel, 1984 - 1986.

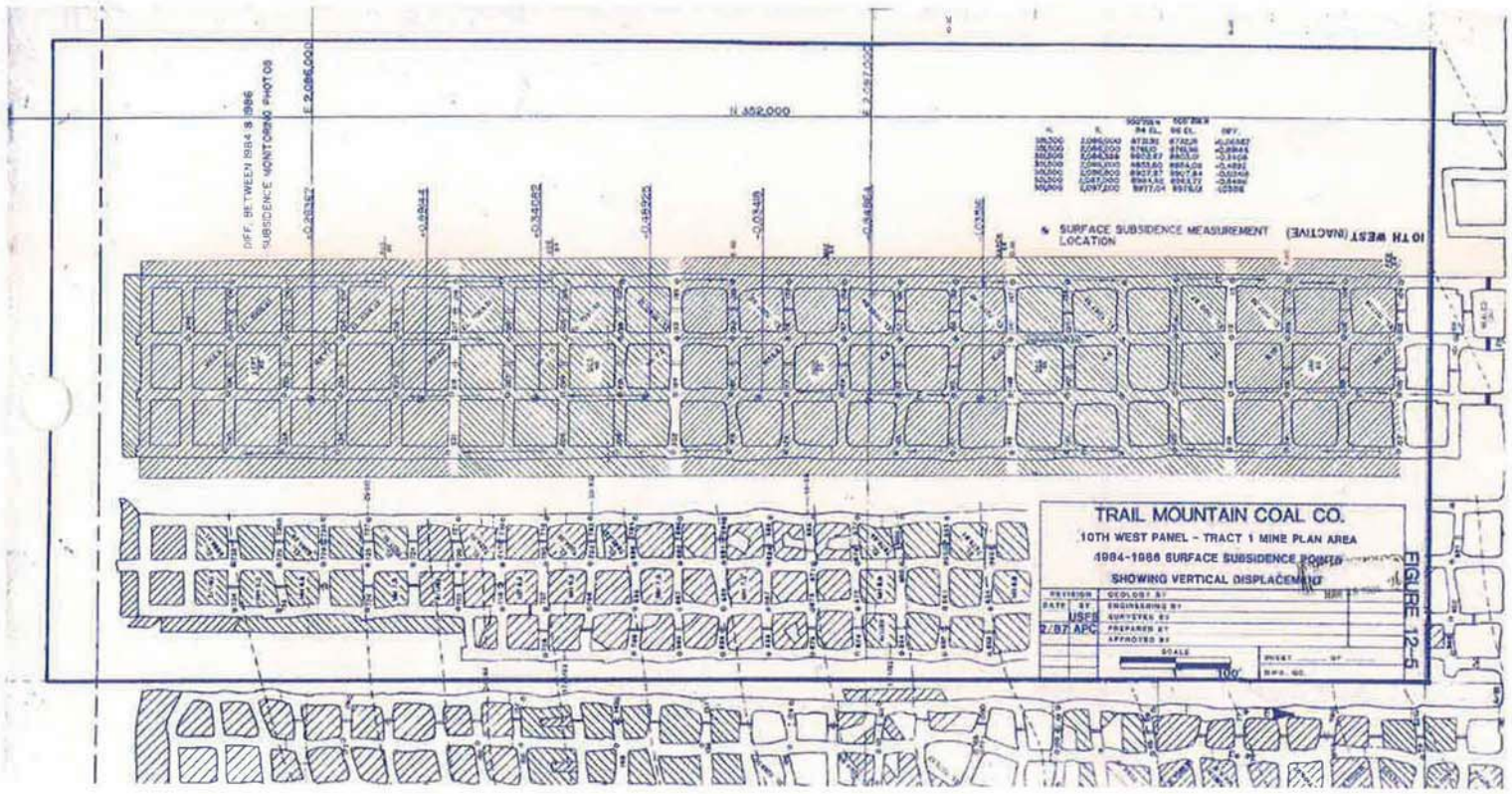
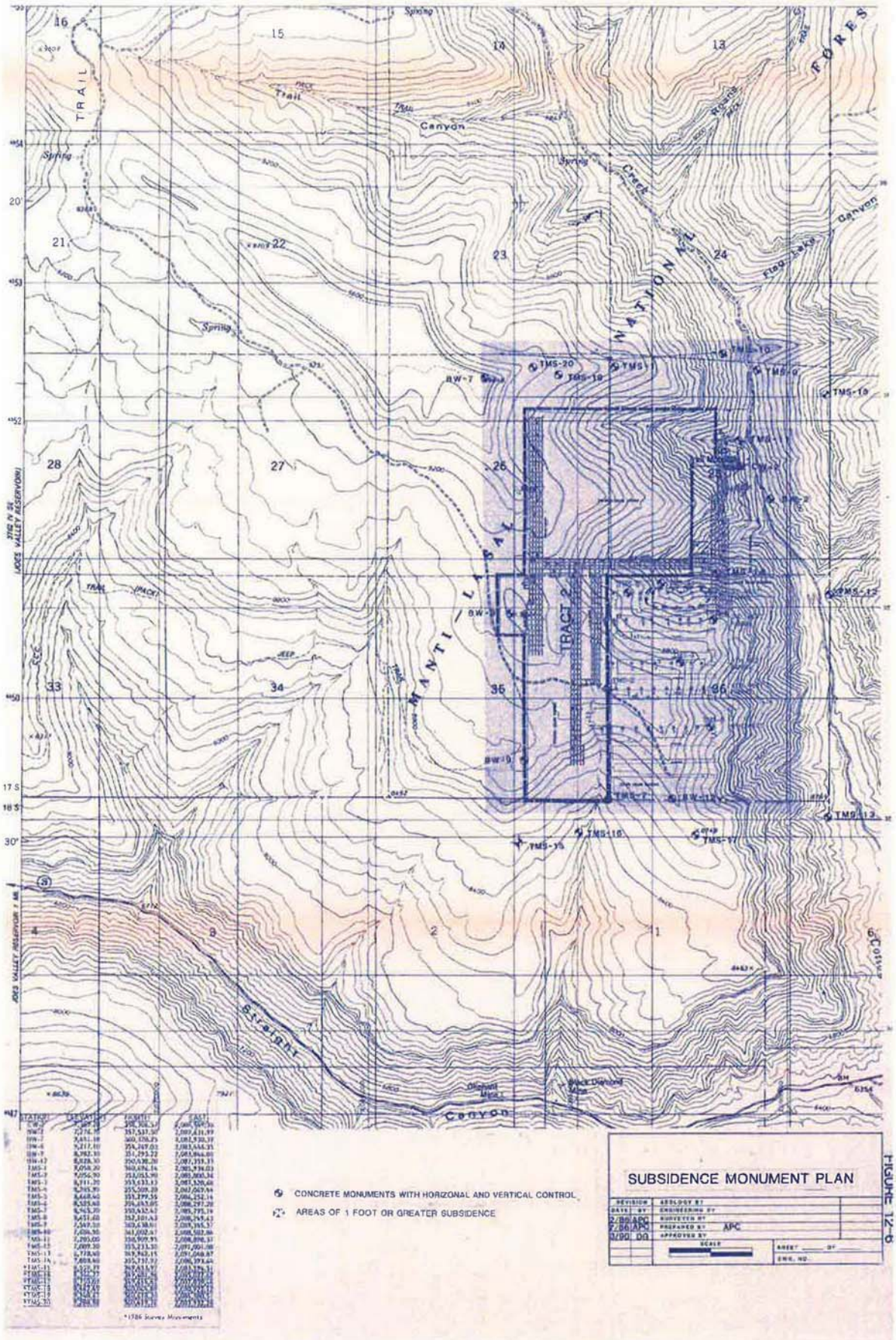
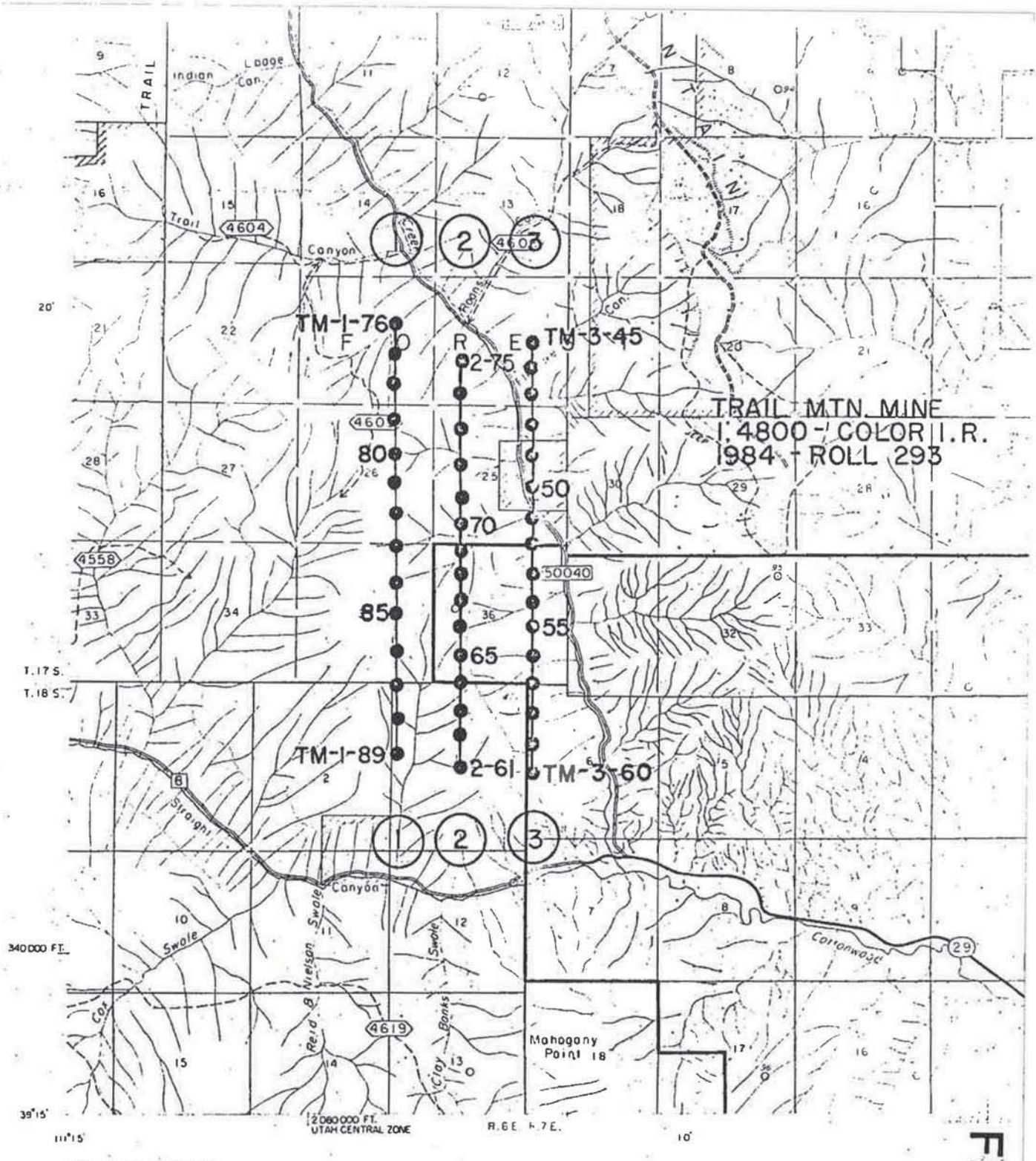

TRAIL MOUNTAIN COAL CO.
10TH WEST PANEL - TRACT 1 MINE PLAN AREA
1984-1986 SURFACE SUBSIDENCE POINTS
SHOWING VERTICAL DISPLACEMENT
SURFACE SUBSIDENCE MEASUREMENT LOCATION
10TH WEST (INACTIVE)
DIFF. BETWEEN 1984 & 1986 SUBSIDENCE MONITORING POINTS
N 352,000
E 2,086,000
USFS
2/87 APC
100'

FIGURE 12-5


SUBSIDENCE MONUMENT PLAN
CONCRETE MONUMENTS WITH HORIZONAL AND VERTICAL CONTROL
AREAS OF 1 FOOT OR GREATER SUBSIDENCE
TRACT 2
MANTI-LA SAL
TRAIL
Canyon
Spring
Creek
Straight
TMS-1
TMS-2
TMS-3
TMS-4
TMS-5
TMS-6
TMS-7
TMS-8
TMS-9
TMS-10
TMS-11
TMS-12
TMS-13
TMS-14
TMS-15
TMS-16
TMS-17
TMS-18
TMS-19
TMS-20
BW-1
BW-2
BW-7
BW-9
BW-12
APC
FIGURE 12-8

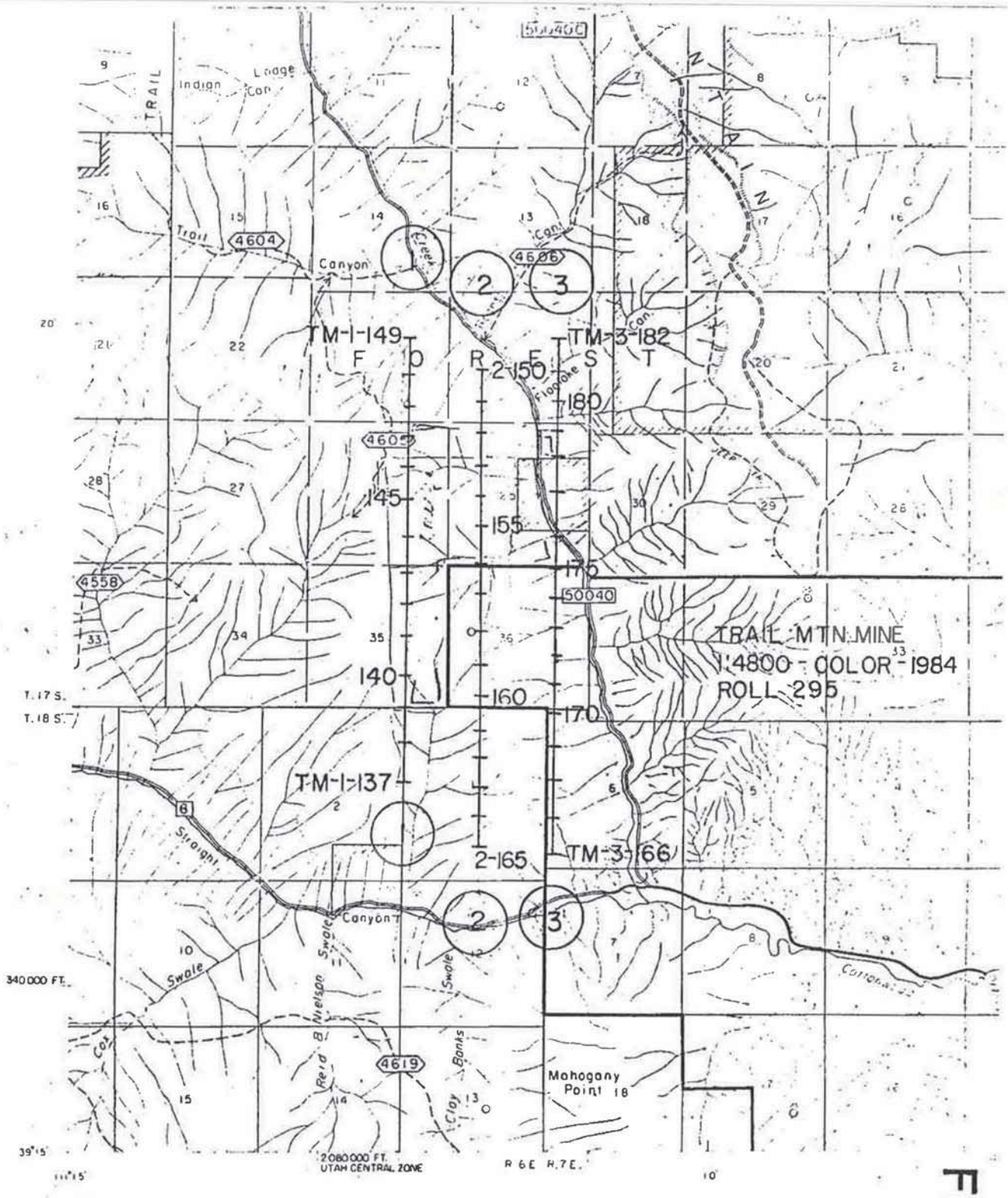



USFS Planimetric Series Map
Constructed by Photogrammetric Methods
From 1:60,000 Photography Dated 1954-55
Polyconic Projection 1927 NAD
10,000 ft Grid Based on Utah Coordinate System, Central Zone
Edited and Revised 1963

21-A

GAP FLIGHT 'A'

FIGURE 12-7




USFS Planimetric Series Map
Constructed by Photogrammetric Methods
From 1:60,000 Photography Dated 1954-55
Polyconic Projection 1927 NAD
10,000 ft. Grid Based on Utah Coordinate System, Central Zone
Edited and Revised 1963

21-A

GAP FLIGHT A

FIGURE 12-8

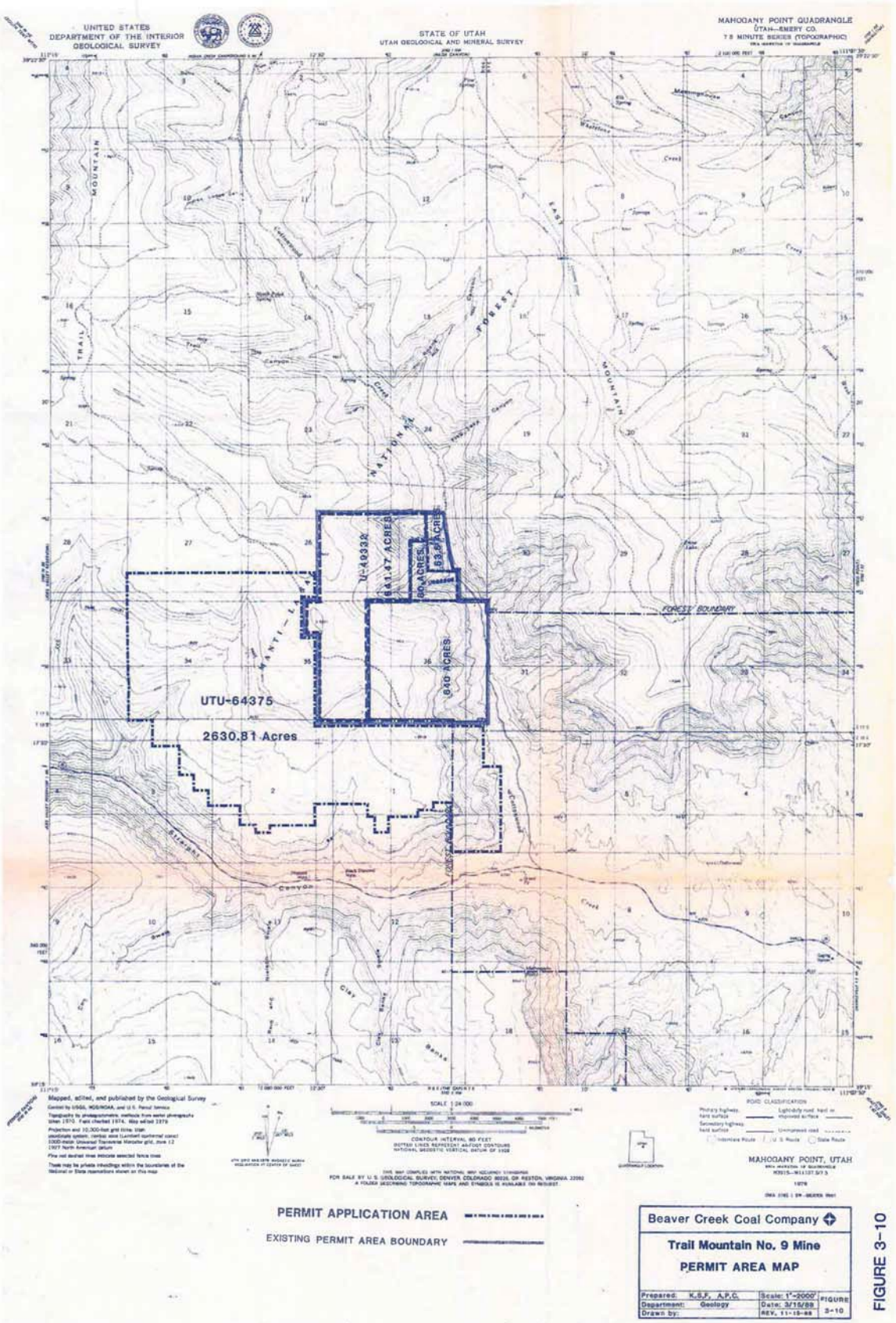

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
STATE OF UTAH
UTAH GEOLOGICAL AND MINERAL SURVEY
MAHOGANY POINT QUADRANGLE
UTAH—EMERY CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
MOUNTAIN TRAIL
NATIONAL FOREST
EAST MOUNTAIN
FOREST BOUNDARY
U-49338
641.47 ACRES
80 ACRES
83.81 ACRES
640 ACRES
UTU-64375
2630.81 Acres
Mapped, edited, and published by the Geological Survey
SCALE 1:24 000
CONTOUR INTERVAL 80 FEET
MAHOGANY POINT, UTAH
PERMIT APPLICATION AREA
EXISTING PERMIT AREA BOUNDARY
Beaver Creek Coal Company
Trail Mountain No. 9 Mine
PERMIT AREA MAP
Prepared: K.S.F., A.P.C.
Department: Geology
Drawn by:
Scale: 1"=2000'
Date: 3/15/88
REV. 11-15-88
FIGURE
3-10

FIGURE 3-10

# CHAPTER 6
# GEOLOGY

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# GEOLOGY

## 610 Introduction

The purpose of this chapter is to explain the geologic setting and characteristics of the coal and rock units in the Mine permit area.

### 611 General Requirements

The geologic resources in the Mine area are discussed in Sections 621 through 627 of this chapter. The plans for casing and sealing of exploration holes and for subsidence monitoring are addressed in Sections 631 through 632. Fossil Rock has leased the Cottonwood Tract Lease, although this lease will not be mined until permitted, baseline information associated with the lease is provided in this chapter.

### 612 Certifications

Maps, plans; and cross-sections presented in this chapter, when required by the regulations, have been certified by a professional engineer or professional geologist.

## 620 Environmental Description

### 621 General Requirements

This section presents the regional and site-specific geologic information for the Mine area. The site-specific geologic information for the nearby waste rock disposal site is contained in Chapter 6 of the waste rock volumes.

### 622 Cross Sections, Maps and Plans

Plate 6-2 presents the geologic base map for the permit and adjacent area. This plate shows the elevation and location of core samplings. Plate 6-1 is a generalized cross section showing the Hiawatha Seam to be mined, and each stratum of overburden and the stratum immediately below the Hiawatha Seam. The mine plan map (Plate 5-4) shows coal crop lines and the strike and dip of the coal to be mined within the proposed permit boundary. Gas wells and the gas transmission line are shown on Plate 4-1.

### 623 Geologic Determinations

The information required by UDOGM to determine the acid or toxic forming characteristics of the site strata is presented in Section 624.300. The information required by UDOGM to determine whether the reclamation plan, described in Section 540, can be accomplished as presented in Section 624. The information required to prepare the subsidence control program is addressed in Section 624.

### 624 Geologic Information

#### 624.100 Regional Setting

General geology of the area has been described by E. M. Spieker (USGS Bulletin 316, 1931) and H. H. Doelling (Utah Geology & Mineral, Survey Monograph Series No. 3, 1972). Details of the quality and mining characteristics of the Hiawatha seam are based on experience from the Mine.

The Mine is located near the center of the Wasatch Plateau coal field (Doelling, 1972), three miles from the mouth of Cottonwood Canyon and 11 miles from Orangeville (see Figure 6-1 Location Map). The coal field is oriented nearly north-south and is bounded to the east by an erosional escarpment; the west boundary roughly parallels the drainage divide of the Wasatch Plateau. The plateau has a vertical relief of up to 2,500 feet, rising from the Castle Valley below. In the vicinity of Trail Mountain, the terrain can be characterized by narrow flat-topped mesas surrounded by heavily vegetated slopes which extend to precipitous cliffs leading to the valley below. The dip of the strata is generally toward the southwest, ranging from approximately five to eleven percent (three to six degrees) over the mine plan area.

The Wasatch Plateau coal field was formed along the western shoreline of the Cretaceous Seaway. Sediments deposited in the sea and coastal areas were derived mainly from western Utah. The Cretaceous Seaway oscillated due to tectonic events forming marine and non-marine sequences characteristic of fluvial, wave-dominated delta, and strand-plain deposits. Formations exposed in the Trail Mountain region range from Upper Cretaceous to Tertiary. Figure 6-2 (Stratigraphic Correlation Diagram) and Plate 6-1 (Geologic Cross Section) depicts the sequence of rock units which occur in the Wasatch Plateau coal field.

Older Cretaceous formations including members of the Mancos Shale are exposed in Castle Valley and extend to the escarpment at the eastern edge of the Wasatch Plateau. The steeper sections of the escarpment belong to the Mesaverde Group formations and the uppermost units on the plateau are the latest Cretaceous and early Tertiary rocks (Doelling 1972).

Structure. Strata in the northern part of Trail Mountain are gently up-folded into the Flat Canyon anticline. In the southern part of Trail Mountain the strata gently dip into the Straight Canyon syncline. Both structures have a bearing of approximately north $50^0$ east and plunge to the southeast. The dips of the strata on Trail Mountain generally are $2^0$ or $3^0$ and rarely exceed $5^0$ (Lines 1984).

Faults – The Mill Fork Graben, Roan Canyon fault Graben and Straight Canon Syncline all extend into the mine plan area. The Joe's Valley fault zone, trending north to south is located immediately west of the mine plan area.

The Joe's Valley fault breaks the continuity of the geologic units along the west edge of Trail Mountain. Davis and Doelling (1977) estimate approximately 2,300 feet of vertical displacement along the fault in this area. The Joes Valley fault is the eastern fault boundary of a graben structure, approximately 2 miles in width, and extends at least 20 miles north of Trail Mountain and at least 40 miles to the south.

Both the Joe's Valley fault and the Straight Canyon Syncline lie west of the permit area (See Plate 6-3). Data gathered by PacifiCorp indicate that the strike-slip component of the Roans Canyon Fault encountered in the East Mountain property may extend into the Trail Mountain area west of the permit area. On East Mountain both the Straight Canyon Syncline and the Roans Canyon Fault have a bearing of north 50° east. The Hiawatha seam in the permit area has a general dip of approximately 3° to the west-southwest. The mine plan in the permit area will eventually encounter the Mill Fork Graben and the Roans Canyon Fault Graben. Depth of cover over the Hiawatha seam ranges from zero at the outcrop to approximately 2800 feet (See Plate 6-4).

Stratigraphy. The rock formations exposed in the Trail Mountain area range from Upper Cretaceous to Tertiary in age. The formations, in ascending order, are the Masuk Shale member of the Mancos Shale, Starpoint Sandstone, Blackhawk, Castlegate Sandstone, Price River, North

Horn, and Flagstaff Limestone. Figure 6-3 is a generalized section of the rock units with range of thickness and a general lithologic description.

The Masuk Shale member of the Mancos Shale, which outcrops along Cottonwood Creek, is the lowermost stratigraghic unit exposed in the mine plan area. The Masuk Shale member of the Mancos Shale is about 1300 feet thick and consists mostly of gray shale with occasional yellow-gray sandstone interbeds. Westward thinning wedges of the Masuk Shale interfinger with the basal tongues of the Starpoint Sandstone. It is generally void of water.

The Starpoint Sandstone, which is a prominent cliff former, consists of several eastward thinning marine sandstone tongues of medial Campanian age (Clark, 1928). The three members are the basal Panther Sandstone, the middle Storrs Sandstone, and the upper Spring Canyon Sandstone. These sandstone units are generally separated from each other by westward projecting tongues of Mancos Shale. The basal Panther Sandstone is approximately 100 feet thick and consists of massive, well indurated, cross-bedded delta front sandstones. The Storrs Sandstone is located about 120 feet above the top of the Panther Member and consists of 50 feet of soft, friable sandstone. The Spring Canyon is located about 80 feet above the top of the Storrs Member and consist of 100 feet of massive, fine to medium grain, cross-bedded delta front sandstones. Even though the Starpoint formation exists throughout the entire Trail Mountain property, the low permeability and lack of recharge limit its usefulness as a water producing aquifer. Permeability and the limiting factors of recharge, i.e., very little outcrop exposure and limited vertical groundwater migration, are caused by the mudstone layers of the North Horn formation. Locally, the Starpoint Sandstone exhibits aquifer characteristics. These are isolated occurrences where regional faults have created secondary permeability and have been intersected by major canyons with perennial streams. An example is Little Bear spring located in Huntington Canyon.

The Blackhawk Formation overlies the Starpoint Sandstone and is 625-800 feet thick in the Trail Mountain area. The Blackhawk consists of alternating sandstones, siltstones, shales and coal deposited in a deltaic environment. Although coal is generally found throughout the Blackhawk Formation, the economic seams are restricted to the lower 150 feet of the formation. The seam mined at Trail Mountain is the Hiawatha seam, which occurs at the contact between the Blackhawk Formation and the Starpoint Sandstone. The sandstones contained within the Blackhawk Formation are fluvial and increase in number in the upper

portions of the formation. Many of the tabular sandstone channels form local perched water tables. The sandstone beds are fine to medium-grained (Spieker, 1931) and yellow-gray to tan in color (Doelling, 1972). The sands of the Blackhawk are cemented by calcium carbonate or silica with the exception of a few localized areas in which the cement consists almost entirely of clay. Iron is also present in the cement of all but the pure white sandstones (Spieker, 1931). The generally discontinuous nature of the Blackhawk and apparent low specific yield (Cordova, 1964) indicates that the water yielding capabilities of the Blackhawk are only of local importance.

Spieker (1931) identifies three general types of shale in the Blackhawk Formation: ordinary clay shale, carbonaceous shale, and smoke-gray shale (all continental in origin). The ordinary clay shale is gray to green, granular and normally soft at the outcrop; the carbonaceous shale is brown to black, massive and laminated; and the smoke-gray shale is tough and leathery, and in its unweathered state is hard and homogeneous (Spieker, 1931). The presence of shale acts as a significant barrier to the vertical movement of water within the Blackhawk Formation.

The Castlegate Sandstone immediately overlies the Blackhawk; it is 250-300 feet thick and consists of mostly coarse-grained often conglomeratic sandstones. The Castlegate normally forms a massive cliff on the canyon walls. The formation is considered to be fairly permeable but, where it has been intersected by drill holes, has never been found to be water-saturated. It is oftentimes dry or slightly damp in some zones. It is void of significant water because it lacks adequate recharge.

The Castlegate Sandstone, generally considered a member of the Price River Formation (Spieker, 1931), consists of massive, medium to coarse-grained sandstone beds, containing conglomerate with a matrix of grit (Doelling, 1972) in places. The Castlegate beds are occasionally broken by sandy, hard, gray shale and at times by thin lenses of coal (Doelling, 1972).

The Price River Formation overlies the Castlegate and consist mainly of medium- to coarse-grained sandstone with occasional interbeds of shale and carbonaceous shale. Individual beds are not as massive as the Castlegate Formation and are more friable, thus eroding

more easily and forming step-like outcrops (Doelling, 1972). Although the unit has a high porosity, its apparent low permeability (Cordova, 1964) reduces its water-yielding capabilities except through fractures. It is generally void of water because it lacks adequate recharge.

The top of the plateau consists mostly of the North Horn Formation. The North Horn Formation straddles the Cretaceous/Tertiary boundary. According to Spieker (1931), the Wasatch Formation (North Horn) contains a highly varied assemblage of rock types. In the central part of the plateau the lower member of the North Horn consists predominantly of varicolored shale, in which the combinations of various shades of red, purple, chocolate-brown, green and gray are characteristic of the coloring of Wasatch rocks in the general region, but it contains many irregular beds of gray, brown and cream-colored sandstone of various texture and thin beds of fresh water limestone. The thickness of the North Horn Formation on Trail Mountain ranges from 750 to 800 feet and increases to the west.

Lenticular sandstone channels are oftentimes present in the upper and lower portions of the formation. Water which percolates down fractures from the overlying Flagstaff Limestone works its way into the sandstones, forming the perched water tables. The actual lateral extent, or correlation, between the perched water tables has not been identified; and it is not practical to do so because the tables are limited in extent and variable in stratigraphic location. Many springs have been identified where the sandstone channels intersect the land surface.

The lower two-thirds (upper Cretaceous in age) of the formation is generally highly bentonitic mudstone, which is impermeable. It is likely that this material is acting as an aquiclude, preventing adequate recharge from reaching the Price River Formation or Castlegate Sandstone below. The mudstones present swell when they come in contact with water; therefore, vertical migration of water along fractures through this material is limited because the fractures are sealed by the swelling clays.

The depths of the aquifers in the North Horn Formation are variable due to the rugged topography. The localized perched water tables may either intersect the surface of the ground or be covered by as much as 1,000 feet of overburden. They are located at least 1,400 feet above the coal seam to be mined. Communication of water between the perched aquifers in the North Horn Formation and

the water flowing into the mine is limited in quantity and occurs very slowly. The monitoring of the numerous springs located on Trail Mountain gives the Applicant the ability to assess any effects that mining might have on the North Horn Formation perched aquifers.

The Flagstaff Limestone forms the uppermost peaks and caps on the Wasatch Plateau. It is a light-medium gray, fine-grained, occasionally fossiliferous limestone. The unit forms a white cliff, consisting of white, light gray and thin-bedded lacustrine limestone with some thin beds of gray shale and white volcanic ash. On top of Trail Mountain in the NW 1/4 of Section 22, T17S, R6E the thickness of the Flagstaff Limestone was measured at 105 feet (Davis and Doelling, 1977). This formation displays a strong joint pattern which permits good groundwater movement both vertically and horizontally through the formation. Erosional remnants of the Flagstaff Limestone are located on summits and ridges adjacent (Davis and Doelling, 1977).

**Drill Logs and Chemical Analyses.** The Applicant requests that this information (Appendix 6-1 and 6-2) remain confidential and that public access to these sections be limited as provided under Section 40-10-1 0(4) of the Act.

### 624.200 Test Boring and Drillhole Data (overburden removed)

The Mine does not plan to remove any overburden above the coal seam to be mined, therefore regulations related to overburden removal do not apply.

### 624.300 Test Boring and Drillhole Data (overburden not removed)

**Lithologic Logs**. Drill holes on and adjacent (within ¼ mile) to the permit area are shown on the Plate 5-4. Due to the competitive nature of the coal lease sales and the fact that unleased federal coal exists adjacent to the current lease, drill hole logs (Appendix 6-1 Confidential), coal thicknesses and quality information are considered proprietary at this time. Only general information will be submitted with this application. The following table presents coal quality characteristics:

| TABLE 6-2 COAL QUALITY CHARACTERISTICS | |
|---|---|
| PARAMETER | APROXIMATE ANALYSIS (As Rec'd) |
| % Moisture | 7.5% |
| %Ash | 9.3% |
| % Sulfur | 0.57% |
| BTU | 12,063 |
| Volitile Matter | 38.90 |
| Fixed Carbon | 43.85 |

Acid, Toxic, and Alkaline Chemical Analyses (above and below the coal seam) - Core Laboratories, Inc. performed an analysis on a sample of the floor and roof material in the center of the permit area at Section 1 West and 40th cross-cut. The results indicate very low pyritic sulfur and high neutralization potential of high $C_1CO_3$ equivalent; therefore, mine acid drainage is not a potential problem. (See Table 6-3, at the end of text)

Two additional sets of samples have been taken from the northwest and southwest areas of Lease 49332 (Main North and 2nd Left). Analyses of the roof and floor material from these areas were run in accordance with the Division Guidelines. Results of these analyses are in Appendix 6-2.

Acid, Toxic, and Alkaline Chemical Analyses (coal seam) - Commercial Testing and Engineering Co. performed an analysis of the forms of sulfur on a sample from the second left coal. The results indicate very low pyritic sulfur. See table below and Appendix 6-2.

| TABLE 6-4 PYRITE CONTENT - HIAWATHIA SEAM | | |
|---|---|---|
| SULFUR FORMS | % WEIGHT | |
| | As Received | Dry Basis |
| | | |

| | | |
|---|---|---|
| Pyrite Sulfur | 0.10 | 0.11 |
| Sulfate Sulfur | 0.00 | 0.00 |
| Organic Sulfur | 0.41 | 0.43 |
| Total Sulfur | 0.51 | 0.54 |

Properties of Rocks in Room and Pillar Areas - Room and pillar mining not anticipated to be performed at the Mine.

### 625 Additional Geologic Information

It is not anticipated that any additional geologic data will need to be collected for this site.

### 626 Sampling Waivers

The Mine does not request a sampling waiver for this site.

### 627 Description of the Overburden Thickness and Lithology

The Hiawatha seam generally lies directly on the top of the Star Point Sandstone, although 1 to 15 feet of intervening shale is present in some locations. The coal seam has a mineable thickness of 6.5 to 13.5 feet in the permit area. The immediate roof varies in lithology in the mine area and consists of 1 to 5 feet of alternating mudstone, thin coals, and fine-grained sandstone. Above this variable zone is a thick-bedded fluvial sandstone which forms a competent roof (see Figure 6-4 Detailed Column). The nature of the coal seam outcrop is concealed by slump and/or natural burn along much of the west side of Cottonwood Canyon. Depth of cover over the Hiawatha seam ranges from zero at the outcrop to approximately 2800 feet (See Plate 6-4).

### 631 Casing and Sealing of Exploration Holes

The information addressing regulations for casing and sealing of exploration holes is found in Section 765 of this M&RP. The applicant believes all exploration boreholes that have not been used for piezometers have been plugged properly prior to abandonment as required by the regulatory authority. This plugging was the final step in the drilling process prior to abandonment of the well.

### 632 Subsidence Monitoring

Subsidence and subsidence monitoring points are discussed in detail in Section 525 of this M&RP.

### 640 Performance Standards

Exploration holes and boreholes will be permanently cased and sealed according to the requirements of R645-301-631 and R645-301-765.

## References

Clark, F.R., 1928, Economic Geology of Castlegate, Wellington, and Sunnyside Quadrangles, Carbon County, Utah: U.S. Geology Survey Bull., 793 p.

Doelling, H.H., 1972. Central Utah Coal Fields, Utah Geological and Mineralogical Survey Monograph Series No. 3.

Doelling, H.H., and Davis. Utah Geological and Mineralogical Survey Bulletin 112.

Spieker, E.M., 1931. The Wasatch Plateau Coal Field. USGS Bulletin 819.

Open Field Report 81-559, Water Resources Investigation USGS 1981.Geology, an important factor in the groundwater hydrology.

## Table 6-3
## CORE LABORATORIES, INC.
## ANALYSIS REOIRT

April 20, 1983

**NATOMAS COAL COMPANY**

Job No.: 6303-S83027
Chemist: LLZ
Location: Casper, WY

| Client I.D. | Interval | Sample Number | % Pyritic Sulfer | Acid/Base Potential* | Neutralization Potential | meq H+/100gr. | % Clay Fraction |
|---|---|---|---|---|---|---|---|
| Sample No. TMM 1 W, 40 Down | 0.0 - 2.7 ft. | 1 | 0.18 | +81.6 | +87.56 | 11.9 | 2.0 |
| Sample No. TMM 1 W, 40 Up | 2.0 - 4.0 ft. | 2 | 0.33 | +90.2 | +106.5 | 32.5 | |

* ± Tons $CaCO_3$ Equivalent/1000 Tons Material

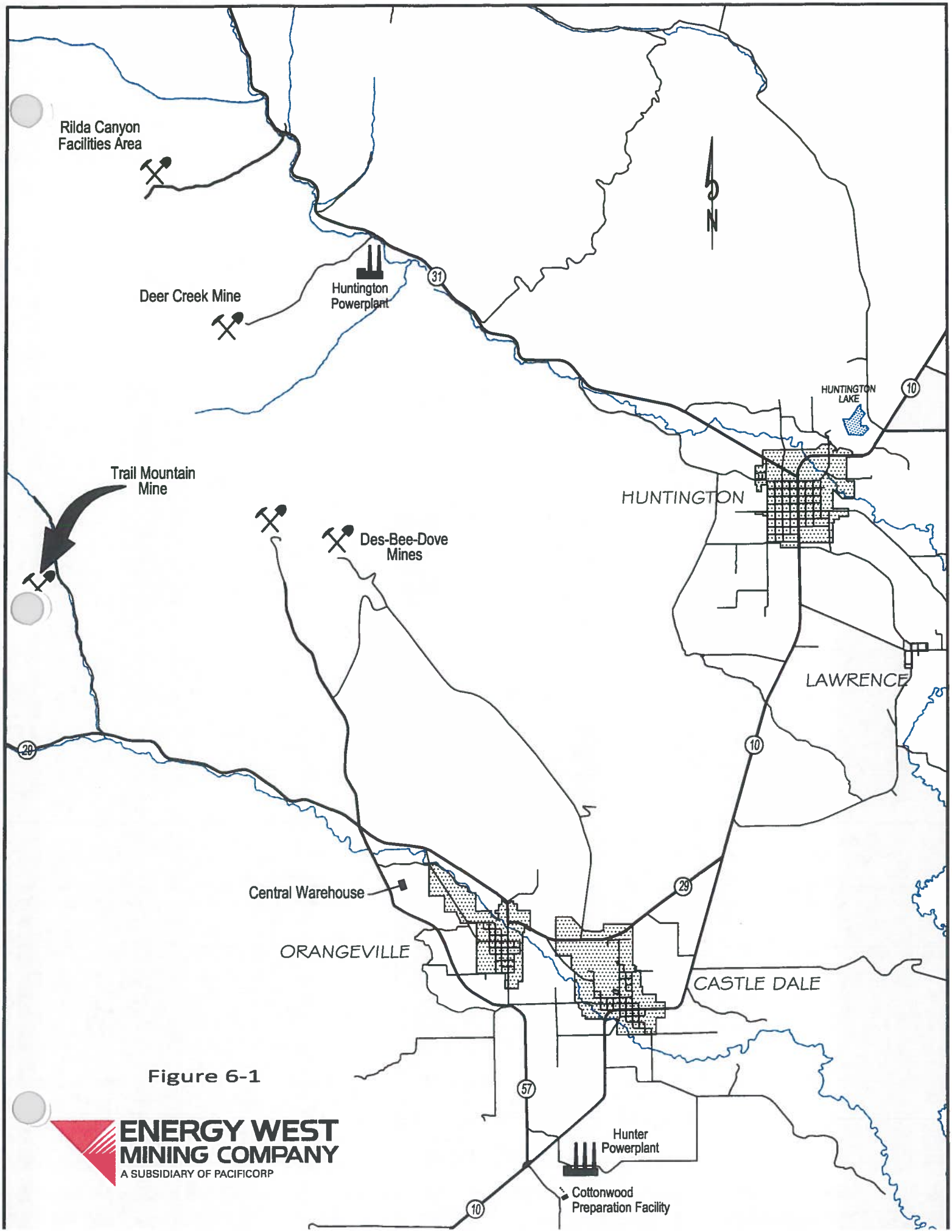



Figure 6-1

ENERGY WEST
MINING COMPANY
A SUBSIDIARY OF PACIFICORP

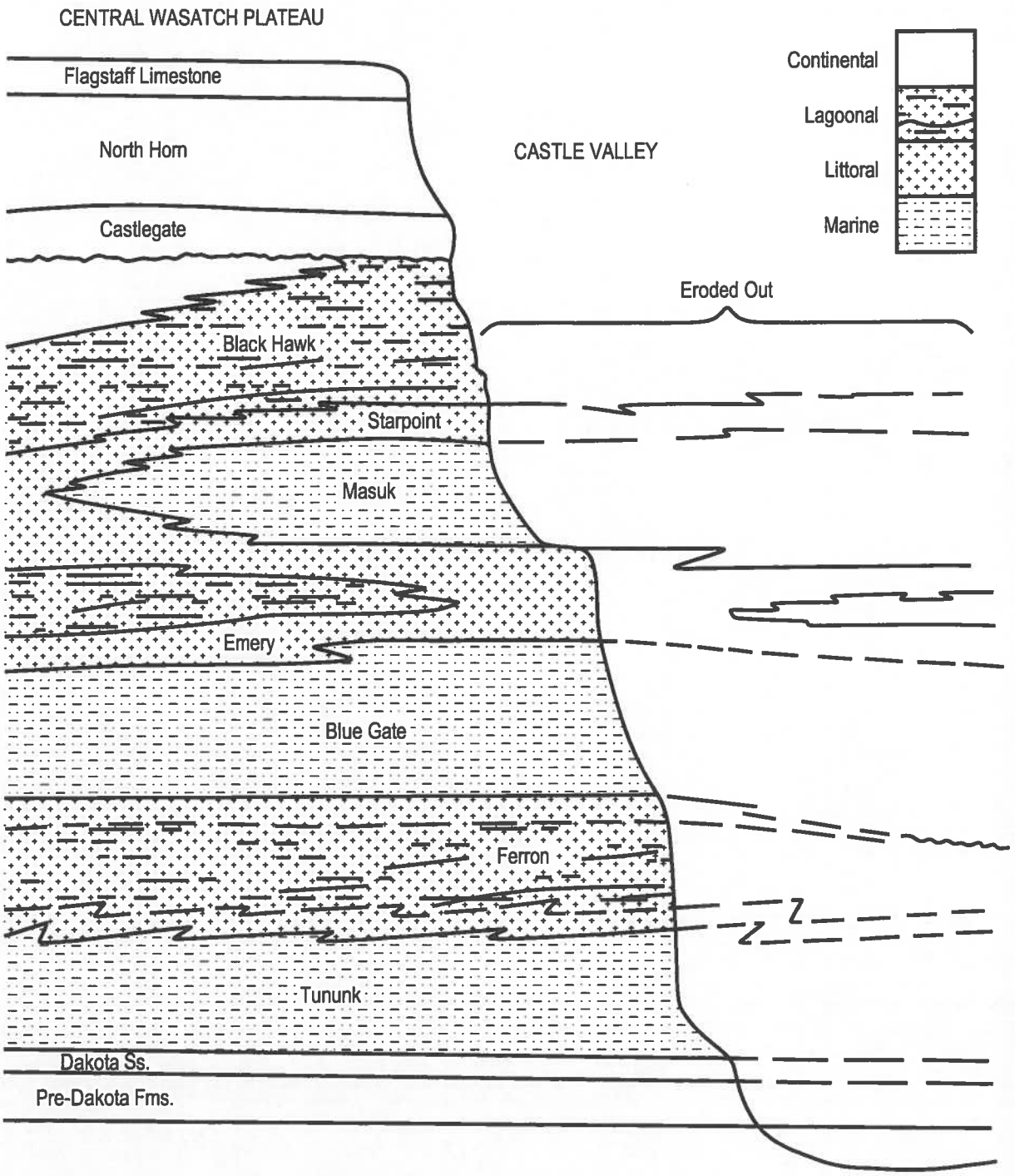



FIGURE 6-2

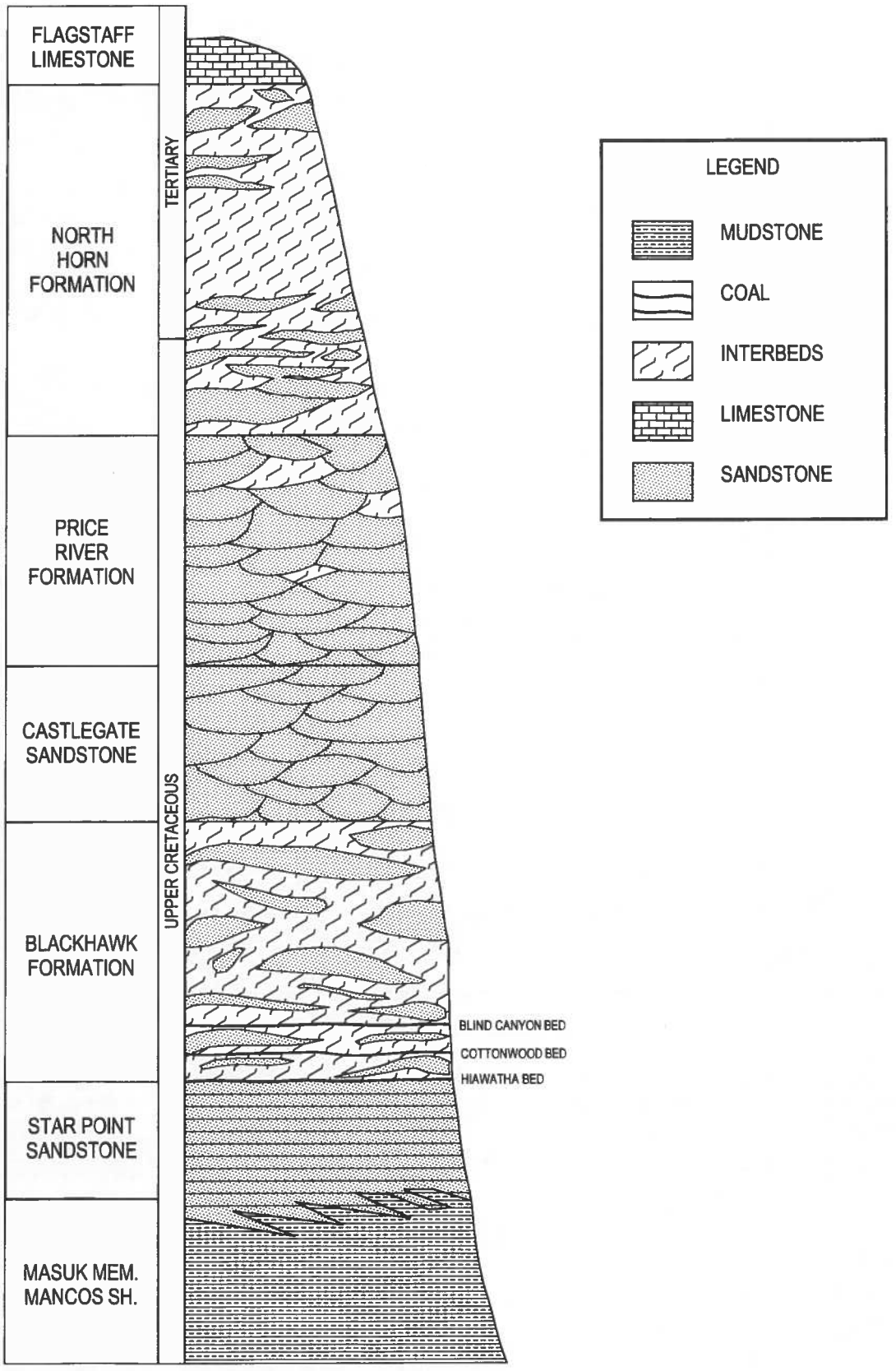
Stratigraphic correlation diagram from central Wasatch Plateau to the Castle Valley

## Figure 6-3

## Stratigraphy of East Mountain
## (Doelling, 1972)

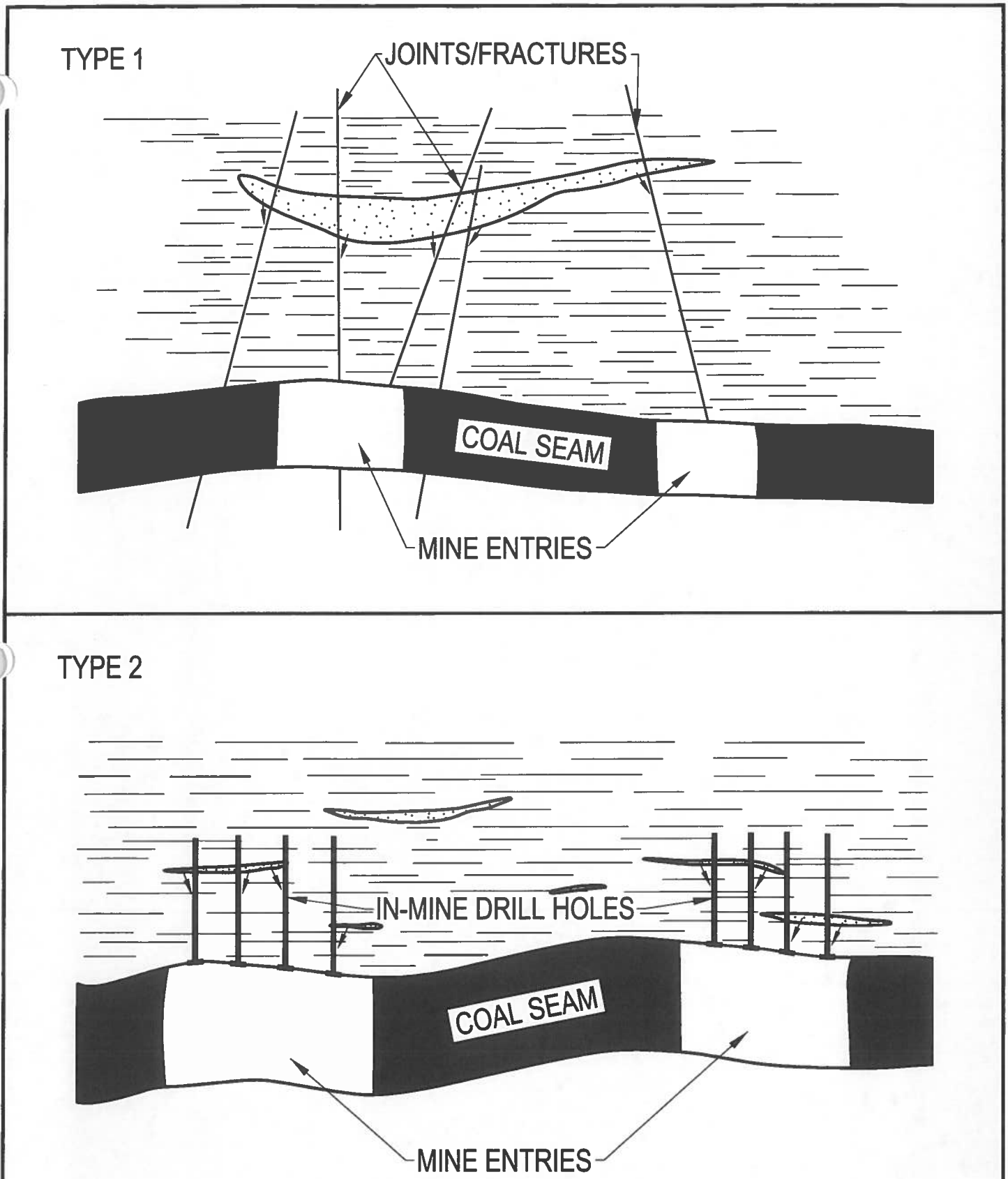
| System | Series | Stratigraphic Unit | | Thickness (feet) | Description |
|---|---|---|---|---|---|
| TERTIARY | Eocene | Green River Formation | | - | Chiefly greenish lacustrine shale and siltstone. |
| | | Wasatch Group | Colton Formation | 300 -1,500 | Varicolored Shale with Sandstone and limestone lenses, thickness to the north. |
| | Paleocene | | Flagstaff Limestone | 200 - 1,500 | Dark yellow-gray to cream limestone, evenly bedded with minor amounts of sandstone, shale, and volcanic ash, ledge former. |
| | | | North Horn Formation (Lower Wasatch) | 500 - 2,500 | Varigated shales with subondinate sandstone, conglomerate and freshwater limestone, thickens to north, slope former. |
| CRETACEOUS | ? Maestrichthian | Mesaverde Group | Price River Formation | 600 - 1,000 | Gray to white gritty sanstone interbedded with subordinate shale and conglomerate, ledge and slope former. |
| | Campanian | | Castlegate Sandstone | 150 - 500 | White to gray, coarse-grained often conglomeratic sanstone, cliff former, weathers to shades of brown. |
| | | | Blackhawk Formation ***MAJOR COAL SEAMS*** | 700 - 1,000 | Yellow to gray, fine- to medium-grained sandstone, interbedded with subordinate gray and carbonaceous shale, several thick *coal* seams. |
| | | | Star Point Sandstone | 90 - 1,000 | Yellow-gray masive cliff-forming sandstone, often in several tongues separated by Masuk Shale, thickens westward. |
| | Santonian | Mancos Shale | Masuk Shale | 300 - 1,300 | Yellow to blue-gray sandy shale, slope former, thick in north and central platear area, thins southward. |
| | | | Emery Sandstone ***COAL (?)*** | 50 - 800 | Yellow-gray friable sandstone tongue or tongues, cliff former, may contain coal (?) in south part of platear if mapping is correct, thickens to west and south. *Coal* may be present in subsurface to west. |
| | Coniacian | | Blue Gate Member | 1,500 - 2,400 | Pale blue-gray, nodular and irregularly bedded marine mudstone and siltstone with several arenaceous beds, weathers into low rolling hill and badlands, thickens northerly. |
| | Turonian | | Ferron Sandstone Member ***MAJOR COAL SEAMS*** | 50 - 950 | Alternating yellow-gray sandstone, sandy shale and gray shale with important *coal* beds of Emery coal field, resistant cliff former, thickens to south. |
| | Cenomanian | | Tununk Shale Member | 400 - 650 | Blue-gray to black sandy marine slope forming mudstone. |
| | Albian | Dakota Sandstone *MINOR COAL* | | 0 - 60 | Variable assemblages of yellow-gray sandstone, conglomerate shale and *coal*. Beds lenticular and discontinuous. |

Generalized section of rock formations, Wasatch Plateau coal field.




Detailed Stratigraphic Section

FIGURE 6-4




GROUNDWATER OCCURANCES WITHIN
CURRENT MINE WORKINGS
FIGURE 6-5

APPENDIX 6-1

DRILL HOLE LOGS

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 6-1

## RESOURCE RECOVERY REPORT

## DRILL HOLE LOGS OF THE TRAIL MOUNTAIN TRACT

United States Department of the Interior

OFFICE OF THE SECRETARY

Minerals Management Service
Office of the District Mining Supervisor
2040 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

March 25, 1982

MINERALS MANAGEMENT SERVICE
MAR 25 1982
SALT LAKE CITY, UTAH
RESOURCE EVALUATION

Memorandum

To: Tract Delineation Team

Through: District Mining Supervisor

From: Mining Engineer

Subject: Resource Recovery Report - Trail Mountain Tract, 7,530.91 Acres, Emery County, Utah

The Trail Mountain tract lies between Cottonwood Creek and the Joe's Valley Fault. Part of the east boundary of the tract joins the Natomas coal lease application, U-49332. The south boundary is determined by the Forest Service Straight Canyon Withdrawal Area. The north boundary is along section lines on the south slope of Trail Canyon. The legal description is as follows:

T. 17 S., R. 6 E., SLM, Emery County, Utah

sec. 20, E½E½;
sec. 21;
sec. 22;
sec. 23;
sec. 24, W½W½;
sec. 25, N½NW¼;
sec. 26, N½NE¼, W½SW¼NE¼, W½, and W½W½SE¼;
sec. 27;
sec. 28;
sec. 29, E½;
sec. 32, E½;
sec. 33;
sec. 34;
sec. 35, W½W½E½, and W½.

T. 18 S., R. 6 E.

sec. 1, lots 1 to 8, and S½N½;
sec. 2, lots 1 to 8, and S½N½;
sec. 3, lots 1, 2, and 8.

T. 18 S., R. 7 E.,
sec. 6, lots 4-7, W½SE¼NW¼, W½E½SW¼. 204.95 ✓
204.95 ✓

Containing: ~~7,520.12~~ 7,510.61 acres

Entities expressing interest:

Natomas Coal Company
Suite 124
5970 South Syracuse Street
Englewood, Colorado 80111

Royal Land Company
Suite 600
925 South Niagara Street
Denver, Colorado 80224

The southeastern corner of the proposed tract, the only locality within the tract where coal could be accessed at the surface, is situated northwest of the town of Orangeville, about seven miles by paved state highway 29 (Fig. 1). Siting details, surface features, and culture of the tract are shown on Figure 2. Both the surface and all minerals underlying the tract are in Federal ownership. Tracing northward from its southeastern corner, the tract is bounded on the east by non-coal bearing BLM land (sec. 6), State land, Coal Lease Application U-49332, and by Coal Lease U-083066; on the north by unleased Federal land and State section 16; on the west by unleased Federal land, and on the south by a Forest Service withdrawal area and non-coal bearing open BLM land (Fig. 2).

All but 746.35 acres (located in the southwestern corner) are within the Wasatch Plateau KRCRA. The coal resources are not exposed except within the western part of sec. 6, T. 18 S., R. 7 E., where about 80 acres of the coal lands are eroded.

Sources of information - Publications containing coal data and geologic analyses pertinent to the tract area include Spieker (1931), Doelling (1972), Davis and Doelling (1977), AAA Engineering (1979a and 1979b), and Smith (1981). In addition, geophysical logs of USGS completed drill holes SLB-7, TM-3, -13, and -17 (see Fig. 2) are available at any of the servicing offices of Rocky Mountain Well Log Service. Among these sources can be found essentially all the coal data available to the public applicable to a geological evaluation of the coal resources that might occur within the Trail Mountain Tract.

Geologic setting - Excepting local deposts of alluvium and colluvium, including landslide and talus deposits, rock units cropping out in the tract include, in ascending order, The Masuk Shale Member of the Mancos Formation, Star Point Sandstone, Blackhawk Formation, Price River Formation, North Horn Formation, and Flagstaff Limestone. Ranging in age from Upper Cretaceous to Tertiary, these units are briefly described in Figure 3. The coal seams of economic promise (containing coal ≥ 4 feet in thickness) occur only in the lower 250 feet of the Blackhawk Formation.

Available data indicate that the strata underlying the tract are slightly warped into a broad open syncline, the axis of which plunges gently southward across the tract (Fig. 4). Beds within this structure strike N 20° - W and dip about 3 to 5° southwest. No faults cutting the rocks within the tract have been recognized. Along the western boundary, however, fault strands related to the Joes Valley Fault are likely (Fig. 2). Vertical displacements within this fault zone reportedly exceed 1,000 feet, west side down.

Extent, thickness and nature of the coal deposits - In the vicinity of the tract several seams have been tentatively identified and assigned names (Spieker, 1931). In ascending order the names employed include the Hiawatha, Upper Hiawatha, Cottonwood, Blind Canyon, Bear Canyon, Upper Bear Canyon, and Upper Grimes Wash. The existing data, however, indicate that those coals occurring above the Hiawatha are, generally speaking, highly lenticular, thin, and discontinuous, and evidentially would be of no current commercial interest within the tract. Coal-in-the-solid 4-½ feet thick, is reported in a seam occurring 170 feet above the Hiawatha (R. 17 S., R. 6 E., N½ sec. 25, Plate 4, Davis and Doelling, 1977). No other locality on or immediately adjacent to the tract, however, contains coal ≥ 4 feet in thickness in the several seams occurring above the Hiawatha. Consequently, the Hiawatha is the only coal seam of current economic interest known to occur in the vicinity of the tract.

Only one coal test is located within the boundaries of the proposed Trail Mountain Tract (Fig. 2); all other data of use in assessing the potential coal resources are erratically distributed along the south, east and north perimeter. Application of these data requires extrapolating measurements as much as [illegible] miles away from existing coal measurements. Experience in the Wasatch Plateau coal field, however, clearly demonstrates that critical variables in coal, such as thickness, continuity, rock partings, ash, altitude, roof and floor conditions, and even existence, cannot be evaluated to a meaningful level of confidence without drilling to a density of at least one hole for each 160 acres. In most operational mines an even closer drilling density has proven necessary, to prevent economic disaster. Variations in seam continuity, partings, ash, thickness, and existence, can be due to penecontemporaneous and post-depositional sedimentation. Features such as channeling out the peat deposits, and "rolling" of the normally planar surfaces as the result of differential compaction, are simply too locallized to be detected by less than several holes per section. Clearly, then, in view of the distribution of the coal data shown on Fig. 2, the representation of the tract's coal resource presented in Figs. 4, 5, and 6 are quite literally little more than cartoons designed to tease one into considering an inferred coal resource for possible economic exploitation. Intelligent bidding for the coal value of this tract using presently available data is impossible. The presented geologic framework is based upon a totally inadequate data distribution, consequently, bonus bids are likely to be based on rank ignorance concerning the actual configuration and quantity of the tract's coal resource.

Coal sections of the Hiawatha seam used in this analysis are derived from public and proprietary sources (Fig. 2). With one exception, all of these tests indicate coal in-the-solid or coal including minor partings of rock that are considered minable, ≥ 4 feet in thickness. Among 42 measurements of coal,

the thickness ranges from 3.4 to 10.3 feet. Assuming that this set of coal samples (N=42) represents a population whose characteristics can be expected to occur within the proposed tract, the average thickness ($\bar{X}th$) and standard deviation (S) within the sample, have a significance to the coal resource estimate. The values of these parameters are: $\bar{X}th$=7.4 feet; S=1.7 feet. However, owing to the asymetric distribution of the sampling density (i.e. data clustered in variable density on three sides of the tract's perimeter), the apparent high confidence of this estimate, namely $\bar{X}th$=7.4 $\pm$ 0.5 feet, at the 95 percent confidence level, is misleading and erroneous, even for the the band of coal land specifically sampled. Clearly, the high density of sampling along the eastern border of the tract overwhelms the sparse sampling on the south and the north. The best estimate of the mean thickness of the Hiawatha coal occurring within this belt of coal is, therefore, obtained by weighting the samples distributed along the eastern and southern limbs of the belt to the same level of influence as those on the north. This operation yields the following results:

N=15 $\bar{X}th$=6.8 feet S=1.7 feet

The apparent confidence of this estimate, namely $\bar{X}th$=6.8 $\pm$ 0.9 feet, may well stand the test of time within the "lazy U" shaped band of testing which flanks the tract's perimeter.

The structure contour map drawn at the top of the apparent minable portion of the Hiawatha coal (Fig. 4), and the isopach maps showing depth of overburden and thickness of the Hiawatha coal (Figs. 5 and 6), were calculated and drawn by computer using the Garnet program of the National Coal Resources Data System. These maps, computed from the data sources shown on Fig. 2, indicate that the depth of overburden on the Hiawatha Coal ranges from less than 400 feet at the northeastern tract boundary to about 2,400 feet under the Crest of Trail Mountain. According to the Garnet program the Hiawatha seam averages about 6.9 feet in thickness within the Trail Mountain Tract.

Coal quality - On an as-received basis, the combined weighted average of the assays of seven samples of Hiawatha coal taken from the Trail Mountain mine workings in 1975-76 and four samples of coal obtained by Federally sponsored drilling in the vicinity of Trail Mountain, are shown in Table 1.

Table 1. - Proximate analyses, sulfur and Btu determinations, Hiawatha coal, Trail Mountain area, Utah

| No. of samples | Moisture, (percent) | Ash (percent) | Volatile matter, (percent) | Fixed carbon, (percent) | Sulfur (percent) | Btu/lb |
|---|---|---|---|---|---|---|
| 11 | 4.58 | 8.13 | 40.14 | 47.15 | 0.55 | 12,575 |

On a dry, mineral-free basis this composite sample is 54.52 percent fixed carbon and 45.48 percent volatile matter. On a moist, mineral-matter free basis the sample yields 13,800 Btu/lb and has an apparent rank of high-volatile B bituminous coal (D-388, part 26, ASTM, 1978).

The writer personally examined the coal in the Hiawatha seam during an on-site examination of the Trail Mountain area in 1976. Where exposed at mine entry areas and highwalls along Straight Canyon and Cottonwood Creek, the Hiawatha seam is made up of common banded, bright and dull coal, fusain is sparse, and resin is rare. Locally, especially in the vicinity of the Trail Mountain mine, irregularly shaped dikes and sills of tough, fine-grained clayey sandstone occur within the coal seam. Pyrite-marcasite can be observed as widely dipersed spheroids barely visible under 12X magnification. Non-banded (cannel) coal does not appear to be present in the seam. Veinlets of selenite locally encrust partings between cleats and irregular fracture surfaces.

Coal quantity - The coal resource base for the Trail Mountain tract has been estimated within the following contraints. The tract encloses about 11.75 square miles of land, all but about 80 acres of which is potentially underlain by coal. Only one site located at the northeastern boundary of the tract, directly tests the coal within the tract. Data from other test sites located to the north, east and south of the tract were used to infer the occurrence, structure, and thickness of the coal throughout the tract. This inference requires extrapolation of data sources as far as 4 miles. Because essentially all of the coal measurements are distributed unevenly outside of the tract on its north, east, and south, there is a rationale that permits drawing a structural interpretation of the coal bed thickness and surface. These analytical drawings, based on extremely hazardous extrapolations well beyond the distances justified by experience in the coal field, are hardly better than cartoon representations of an inferred resource. The results, nevertheless, constitute a best possible estimate of the in-place coal resource.

Only one coal seam, the Hiawatha, can be inferred to contain resources of coal in minable thickness. The analysis of the available data using established methods of analytical statistics yields an in-place resource of coal averaging 6.8 feet in thickness underlying 7,447 acres of the tract, or 91,200,000 tons of bituminous coal. This estimate of the Hiawatha coal resource compares very favorably with the estimate made by computer, using the Garnet program, summarized below:

| Distance from measurements (miles) | Average thickness (feet) | Land underlain (acres) | In-place resource (short tons) 1/ |
|---|---|---|---|
| 0.0 - 0.25 | 8.3 | 195 | 2,900,000 |
| 0.25 - 0.75 | 7.4 | 1,558 | 20,700,000 |
| 0.75 - 3.0 | 6.7 | 5,694 | 68,700,000 |
| | Totals: | 7,447 | 92,700,000 |

1/ Rounded to 3 significant digits; the unit weight of the coal employed, 1,800 tons/acre foot, has been assumed from its calculated rank; the estimated resource includes only coal projected $\geq$ 4 feet in thickness.

more than 97 percent of the data available for use in this resource
re located outside the tract perimeter, and because most of the
rce inferences are based on extrapolations, this "best estimate" of the
resource should be treated as extremely tenuous. Also, even though the
do not justify inference of minable coal resources occurring above the
atha seam, it should be noted that minable resources in one or more seams
rring above the Hiawatha, are a matter of record at localities situated
3 miles to the south, 1 mile to the east, and 3 or 4 miles to the north of
tract. In the author's judgement, therefore, the actual coal in place
easily amount to as little as 45,000,000 tons, or as much as 140,000,000

Donald C. Alvord

Donald C. Alvord

osures

/819,1982
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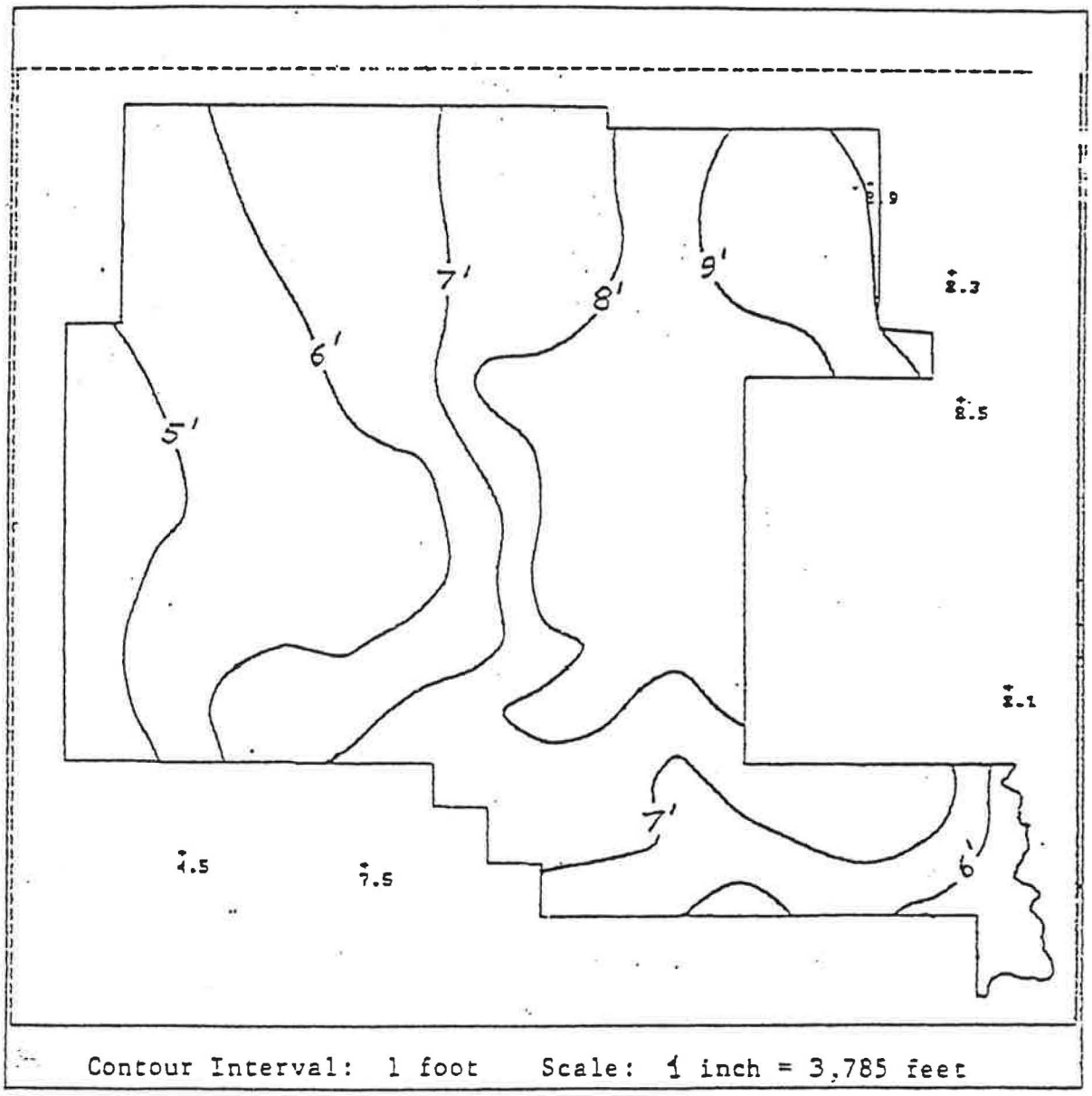
• 111 16 12
• 111 10 45
• 39 16 38
• 39 20 25
our interval • 1.000
hing yes



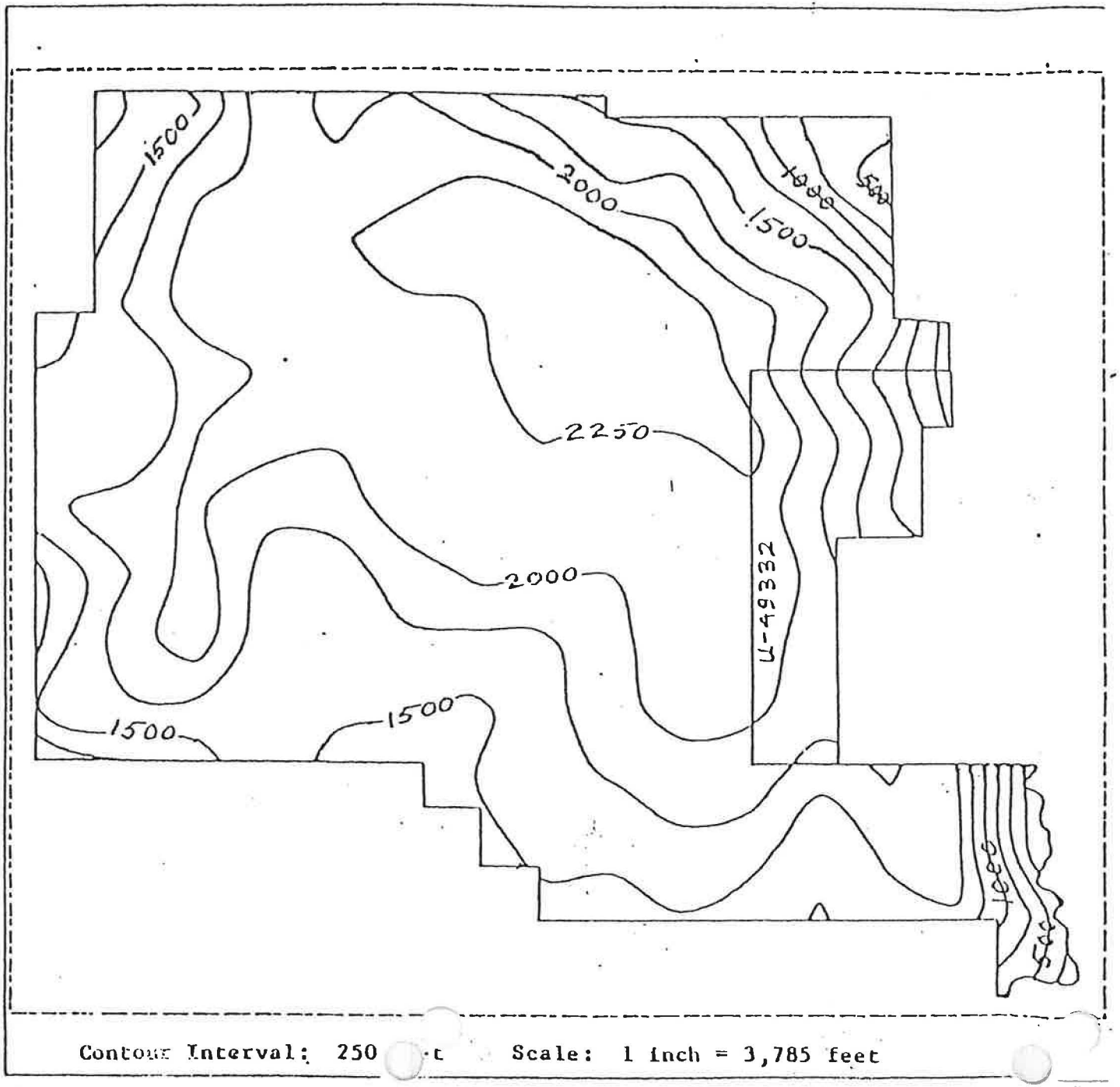

GARNET

NATIONAL
COAL RESOURCES
DATA SYSTEM

Figure 6. Isopach map showing thickness of Hiawatha coal seam, Trail Mountain Tract, Emery County, Utah

Figure 5. Depth of overburden on the Hiawatha coal seam, Trail Mountain Tract, Emery County, Utah

March 22,1982
Observed file = irmpull
Grid file = over3
Grid size = 0.30
Grid type = opgrid
Variable = elev
Units = Feet
Boundary file = total
West = 111 16 4
East = 111 18 45
South = 39 16 40
North = 39 20 22
Contour interval = 250.000
Smoothing yes



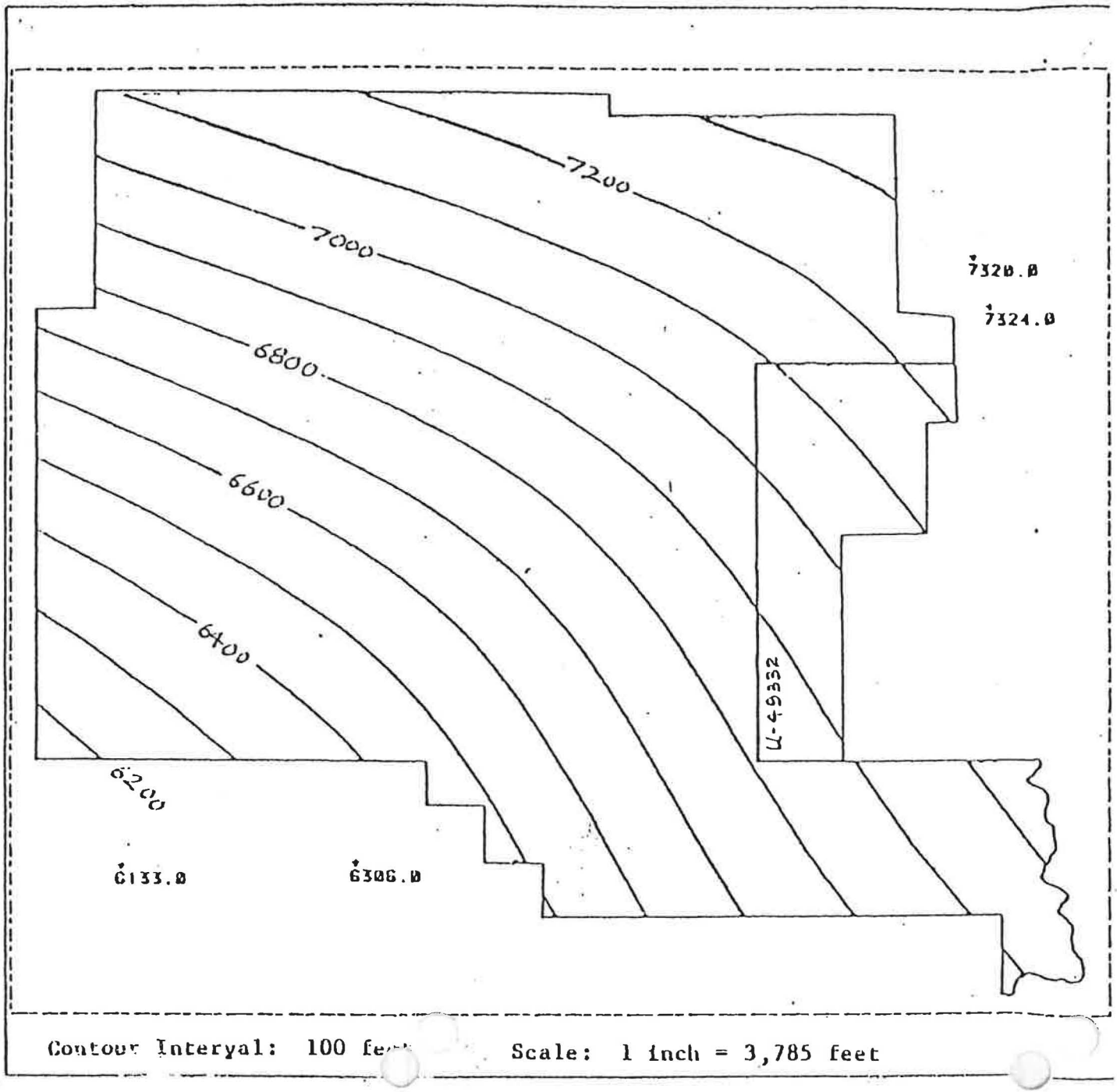

Contour Interval: 250 ft Scale: 1 inch = 3,785 feet

GARNET

NATIONAL COAL RESOURCES DATA SYSTEM

Figure 4. Structure contour map drawn at the top of Hiawatha coal where coal ≥ 4 feet in thickness, Trail Mountain Tract, Emery County, Utah

March 22,1982
Observed file = irmsic
Grid file = irmsic
Grid size = 0.30
Grid type = planar
Variable = elev
Units = Feet
Boundary file = total
West = 111 16 4
East = 111 10 45
South = 39 16 40
North = 39 20 22
Contour interval = 100.000
Smoothing yes




Contour Interval: 100 feet Scale: 1 inch = 3,785 feet

GARNET
NATIONAL COAL RESOURCES DATA SYSTEM

# United States Department of the Interior

OFFICE OF THE SECRETARY
MINERALS MANAGEMENT SERVICE
CENTRAL REGION
DISTRICT RESOURCE EVALUATION OFFICE
1745 West 1700 South, Room 2070
Salt Lake City, Utah 84104

March 25, 1982

Memorandum

To: Tract Delineation Team

From: District Supervisor, Resource Evaluation

Subject: Trail Mountain Tract Summary Report, Emery County, Utah

Introduction -

Tract name: Trail Mountain
Coal field/KRCRA: Wasatch Plateau
USGS quadrangles: Mahogany Point and Joes Valley Reservoir 7½' series
CRO/CDP reports: Hiawatha SW and Joes Valley Reservoir
Acreage: 7,530.12
Surface ownership: Federal (97.3 percent Manti-La Sal National Forest and 2.7 percent Bureau of Land Management)
Legal description: Salt Lake Base and Meridian, Emery County, Utah

| | Acres |
|---|---|
| T. 17 S., R. 6 E. | |
| sec. 20, E½E½; | 160 |
| sec. 21, all; | 640 |
| sec. 22, all; | 640 |
| sec. 23, all; | 579.8 |
| sec. 24 W½W½; | 160 |
| sec. 25, N½NW¼; | 80 |
| sec. 26, N½NE¼, W½SW¼NE¼; W½, W½W½SE¼; | 460 |
| sec. 27, all; | 640 |
| sec. 28, all; | 640 |
| sec. 29, E½; | 320 |
| sec. 32, E½; | 320 |
| sec. 33, all; | 640 |
| sec. 34, all; | 640 |
| sec. 35, ~~W½NE¼, W½, NE¼SE¼~~. Lots 3, 4, S½NW¼, SW¼; | ~~400~~ 380.49 ~~379.8~~ 4,300.29 |
| T 18 S., R. 6 E. | |
| sec. 1, lots 1-8, S½N½; | 447.66 |
| sec. 2, lots 1-8, S½N½; | 451.36 |
| sec. 3, lots 1 and 2, lot 8. | 106.35 |
| | 1,005.37 |

T. 18 S., R. 7 E.

sec. 6, lots 4 to 7, W½SE¼NW¼, and W½E½SW¼.

Containing 7,530.91 acres.

The estimated coal recovery factor could range from about 50 to 70 percent of the minable coal in the Hiawatha seam. The isopach of the Hiawatha seam produced with the Garnet program indicates that longwall mining might be feasible over a large portion of the tract. However, if other unknown geologic conditions prevent the use of longwall equipment, the use of room and pillar mining could be expected to achieve the lower recovery.

The potential mining methods as suggested above appear to be room and pillar with a strong possibility of longwall mining if the Hiawatha bed proves to have the relatively uniform thickness suggested by the Garnet program isopach.

The estimated maximum mining depth will coincide with the greatest overburden which is about 2,400 feet.

The estimated range of annual coal production could be in the 2 to 3 million-ton range if longwall mining can be applied. If not, perhaps, about half of the above might be expected.

The estimated range of mine life will be a reflection of the minable reserves and the mining method that can be applied. Considering the greater potential for conditions favorable to longwall mining if greater reserves prove to be present, it can be expected that the range of mine life will be shortened to about 25 to 35 years.

Note—Although, this appears to be a tract with a large coal resource, access to the coal other than through the Trail Mountain mine is highly questionable. The best alternative access to the coal, other than the Trail Mountain mine, based on favorable topography and lower cost surface site preparation would be through the fee land or Federal coal lease (SL-036407) in Straight Canyon. This access is prevented by the Forest Service Straight Canyon Withdrawal Area of which the north boundary is ¼ mile north of the north property line of the fee land and Federal coal lease SL-036407. The other two potential access routes to the coal would present much higher cost access to the coal seams. The potential access north of the Trail Mountain mine in Cottonwood Canyon would present the costly requirement of driving rock slopes down to the coal bed. The third alternative potential access to the coal would require costly road building from the Cottonwood Canyon road south of the Trail Mountain mine to the near Vertical Cliff Coal Outcrop Zone about 800 feet above the canyon road. The coal outcrop in this area does not appear to be of minable thickness which would require additional costly rock work to get to the minable coal.

Eugene W. Pearson

Eugene W. Pearson

United States Department of the Interior
MINERALS MANAGEMENT SERVICE
CENTRAL REGION
DISTRICT RESOURCE EVALUATION OFFICE
1745 West 1700 South, Room 2070
Salt Lake City, Utah 84104

IN REPLY
REFER TO

May 10, 1982

Memorandum

To: Tract Delineation Team

From: District Supervisor, Resource Evaluation

Subject: Trail Mountain Tract Modification, Emery County, Utah

Introduction - A letter dated April 21 to Max Nielson (BLM) from Reed Christensen (Manti La-Sal National Forest) rejects inclusion of lands outside Planning Area "A" of the Forest Plan in the proposed coal tracts. Consequently, the Trail Mountain Tract is herewith modified to exclude that portion which lies outside Planning Area "A". The deleted lands are described as follows (See Figure 2.):

T. 17 S., R. 6 E., SLM, Utah
sec. 20, E½E½;
sec. 29, E½;
sec. 32, E½.

Containing: 800 acres

These deletions reduce the acreage form 7,530.12 to 6,730.12 acres.

Please refer to the Trail Mountain Tract summary report to the Tract Delineation Team dated March 25, 1982 for maps and discussion concerning the configuration and quality of the coal resource.

Coal quantity - Within the modified tract 6,650 acres of land are inferred to be underlain by coal. All of the coal known to be of minable thickness occurs within a single seam, the Hiawatha. The best estimate of this coal resource, made by computor using the GARNET program of the National Coal Resource Data System, is tabulated as follows:

| Distance from measurments (miles) | Land underlain (acres) | In-place resource (short tons) | Average thickness (feet) 2/ |
|---|---|---|---|
| 0.0 - 0.25 | 182.6 | 2,740,000 | 8.3 |
| 0.25 - 0.75 | 1,468.6 | 20,150,000 | 7.6 |
| 0.75 - 3.0 | 4,998.8 | 62,640,000 | 7. |
| TOTALS: | 6,650. | 85,500,000 1/ | |

1/ Rounded to three significant digits.
2/ Rounded to nearest one-tenth; owing to the computor algorithm, seam thickness average ($\overline{Th}$) is computed after the coal volume has been computed, from the relationship:

$$\overline{Th} = \frac{\text{tons coal}}{(\text{acres})(1{,}800 \text{ tons/acre ft})}.$$

Because more than 97 percent of the data available for use in this resource estimate are located outside the tract perimeter, and because most of the resource inferences are based on extrapolations, this "best estimate" of the coal resource should be treated as extremely tenuous.

Donald C. Alvord

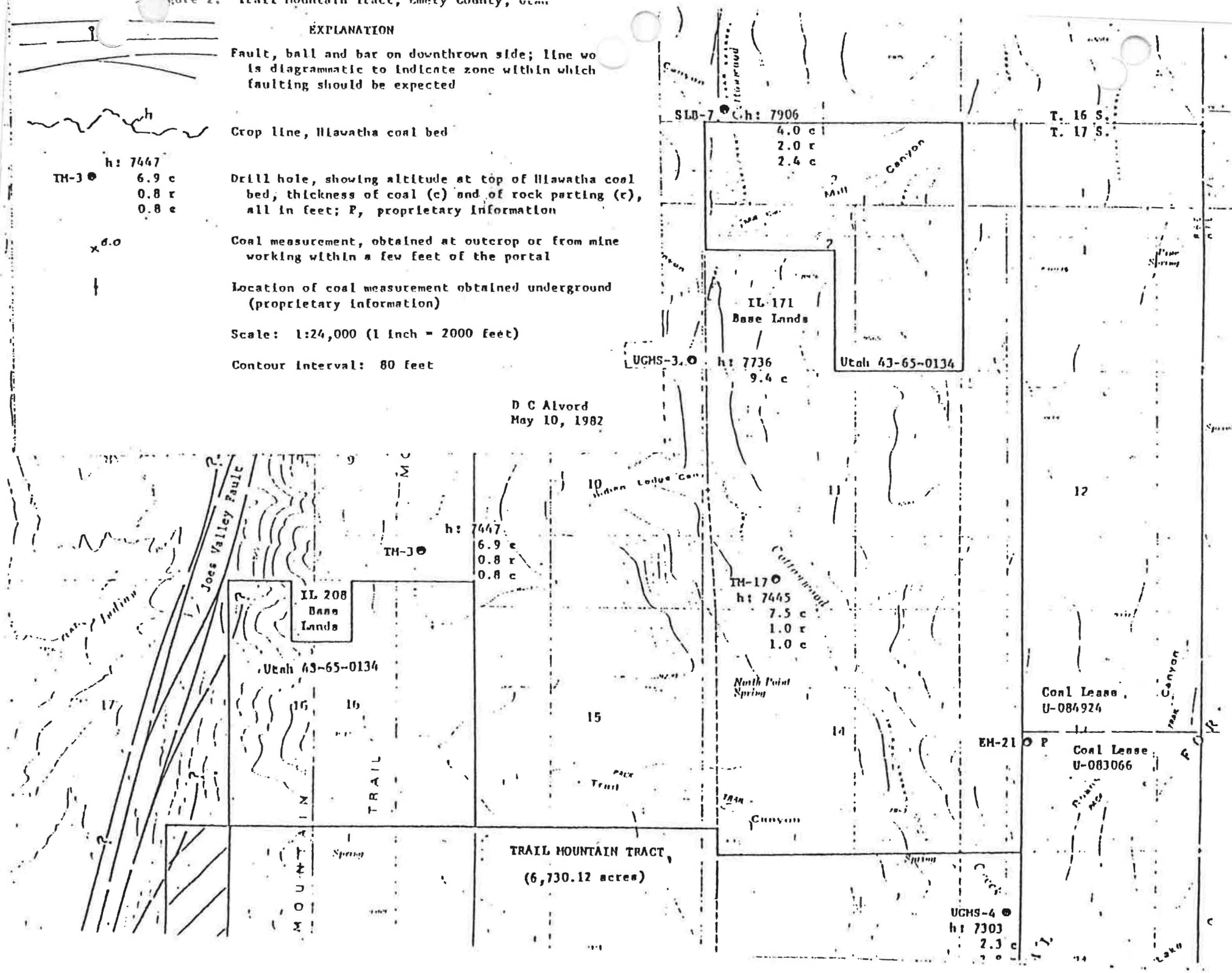
Donald C. Alvord

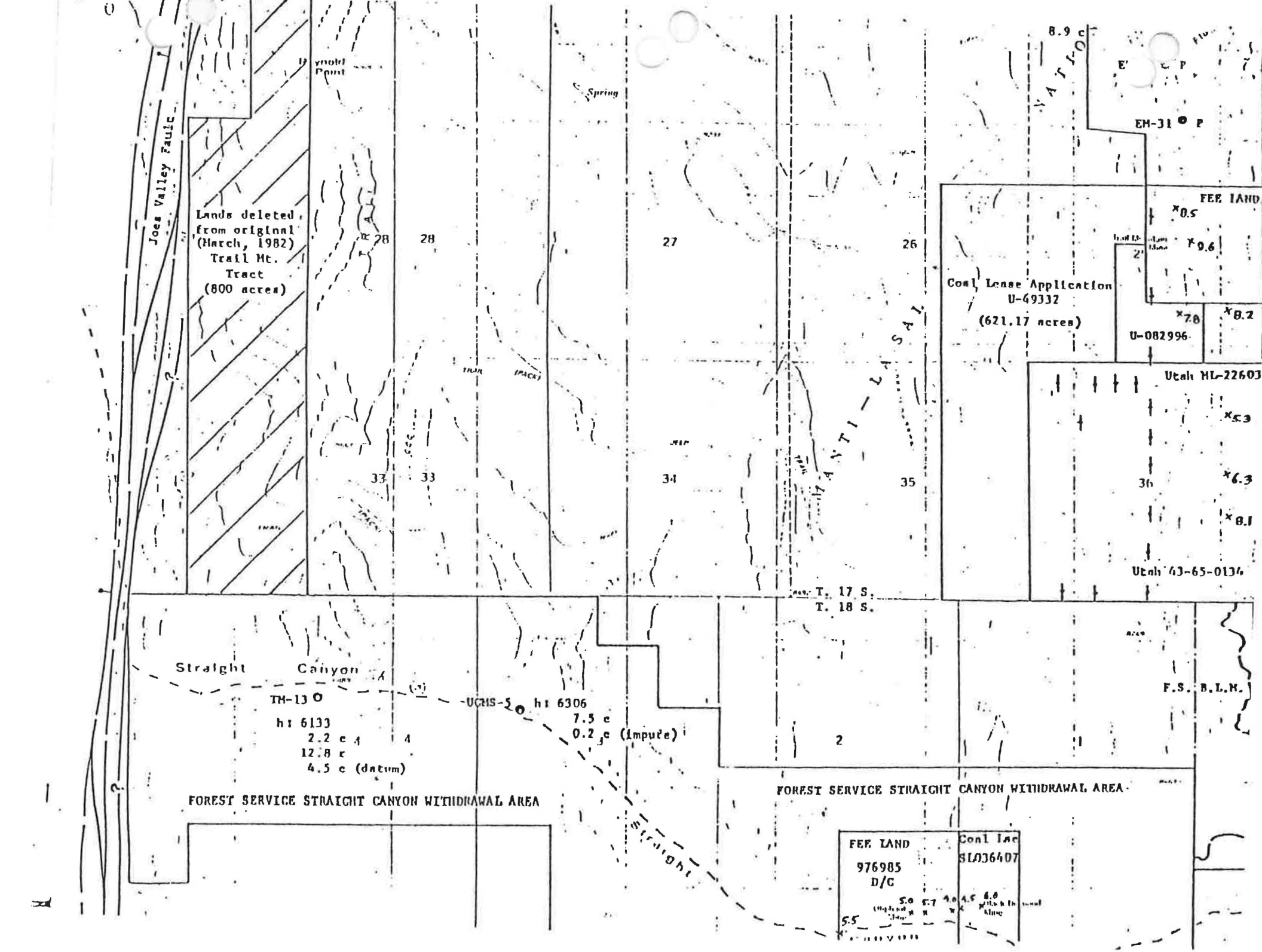
Enclosure

cc: Coal Proj. Mgr., BLM, SLC (w/encls)
Surface Management Agency (w/encls)
Dist. Mining Supvr., SLC (w/encls)
DMM/RE Chron, Denver (w/encls)
Tract Delineation Team Leader, SLC (w/encls)
Tract Delineation File, SLC (w/encls)
Chief, Solid Minerals I, (w/encls)
T&R Files, SLC (w/encls)
Chron File, SLC (w/o encls)

DCAlvord:lt

Figure 2. Trail Mountain tract, Emery County, Utah




Joes Valley Fault
Lands deleted from original (March, 1982) Trail Mt. Tract (800 acres)
TRAIL
28
28
27
26
33
33
34
35
36
2
1
T. 17 S.
T. 18 S.
Coal Lease Application U-49332 (621.17 acres)
U-082996
Utah ML-22603
Utah 43-65-0134
FEE LAND
EM-31
8.9 c
8.2
7.8
9.6
0.5
6.3
5.3
8.1
F.S. B.L.M.
Straight Canyon
TH-13
h: 6133
2.2 c
12.8 c
4.5 c (datum)
UCRIS-5
h: 6306
7.5 c
0.2 c (impute)
FOREST SERVICE STRAIGHT CANYON WITHDRAWAL AREA
FOREST SERVICE STRAIGHT CANYON WITHDRAWAL AREA
FEE LAND
976985
D/C
Coal Lse
SL036407
5.0
5.7
4.0
4.5
6.0
5.5

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
CENTRAL REGION

Office of the District Mining Supervisor
2040 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

MINERALS MANAGEMENT SERVICE

JUN 15 1982

SALT LAKE CITY, UTAH
RESOURCE EVALUATION

REPLY REFER TO:

June 15, 1982

Memorandum

To: Tract Delineation Team

Through: District Mining Supervisor

From: Mining Engineer

Subject: Second Trail Mountain Tract Modification
Emery County, Utah, Resource Recovery Report
Containing 6,970.12 acres.

The Trail Mountain tract has been modified twice in efforts to conform to the Forest Service plan which excludes from mining a large area along the north slope of Straight Canyon and an area east of the Joe's Valley fault that will cause the unnecessary loss of a valuable coal resource.

The probable coal recovery factor is estimated at about 35 percent of the in place coal resource.

The potential mining methods are room and pillar and possibly longwall.

The estimated maximum mining depth will be about 2,400 feet.

The estimated range of annual coal production could be 1 to 2 million tons.

The estimated range of mine life could be 25 to 40 years.

Eugene W. Pearson

Eugene W. Pearson

DRILL LOG DATA

REFERENCE MATERIAL:

Coal Drilling at Trail Mountain, North Horn Mountain, and Johns Peak Areas, Wasatch Plateau, Utah

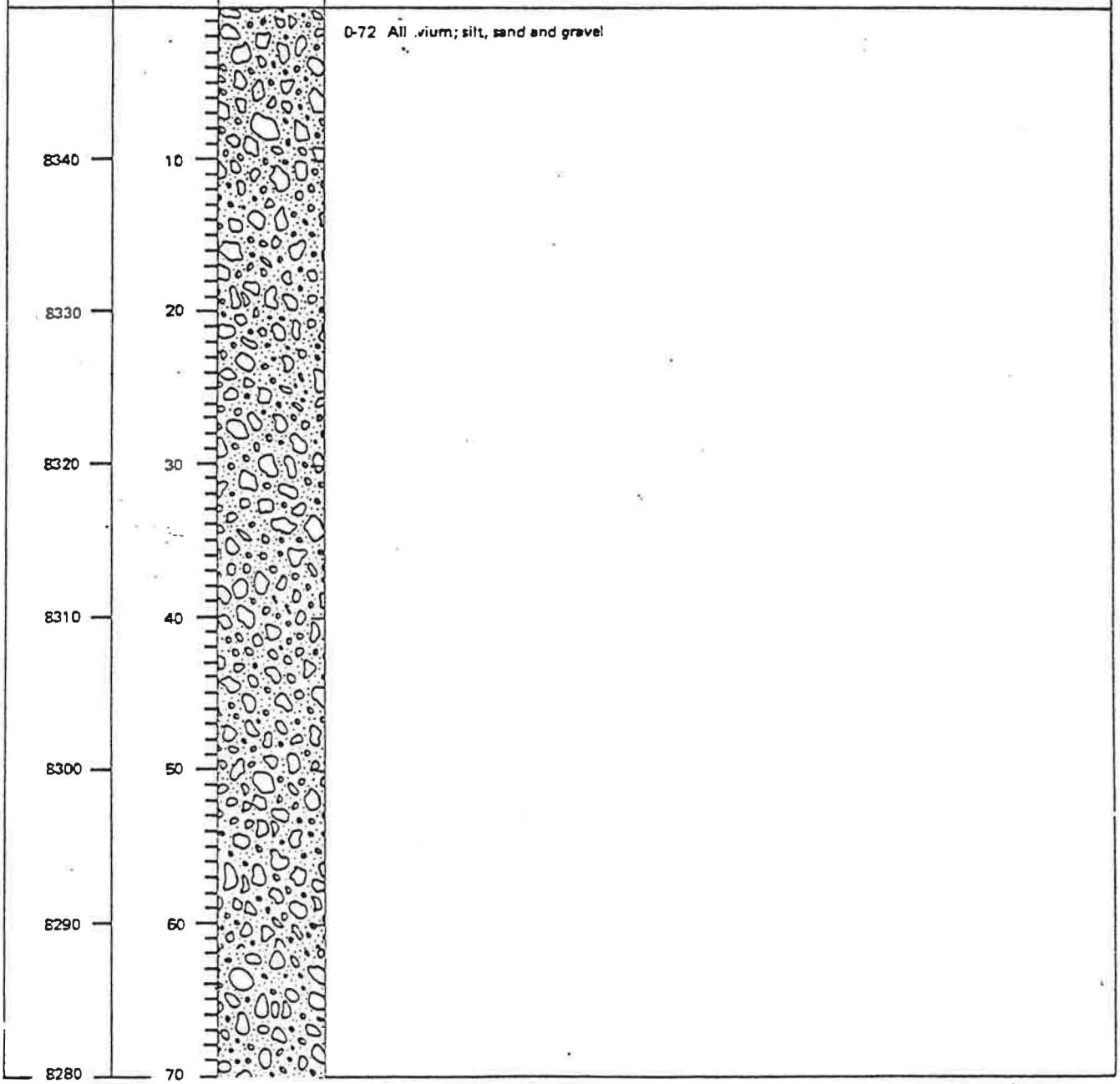
by: F.D. Davis and H.H. Doelling

PROJECT Wasatch Plateau Drilling LOCATION SE¼SE¼ sec. 3, T. 17 S., R. 6 E. SHEET 1 OF 9

BEGAN August 13, 1975 COMPLETED August 24, 1975 TOTAL DEPTH OF HOLE 632.5 feet

CORE RECOVERY (%) 100 FEET 332.5 feet GROUND ELEVATION 8,350 feet

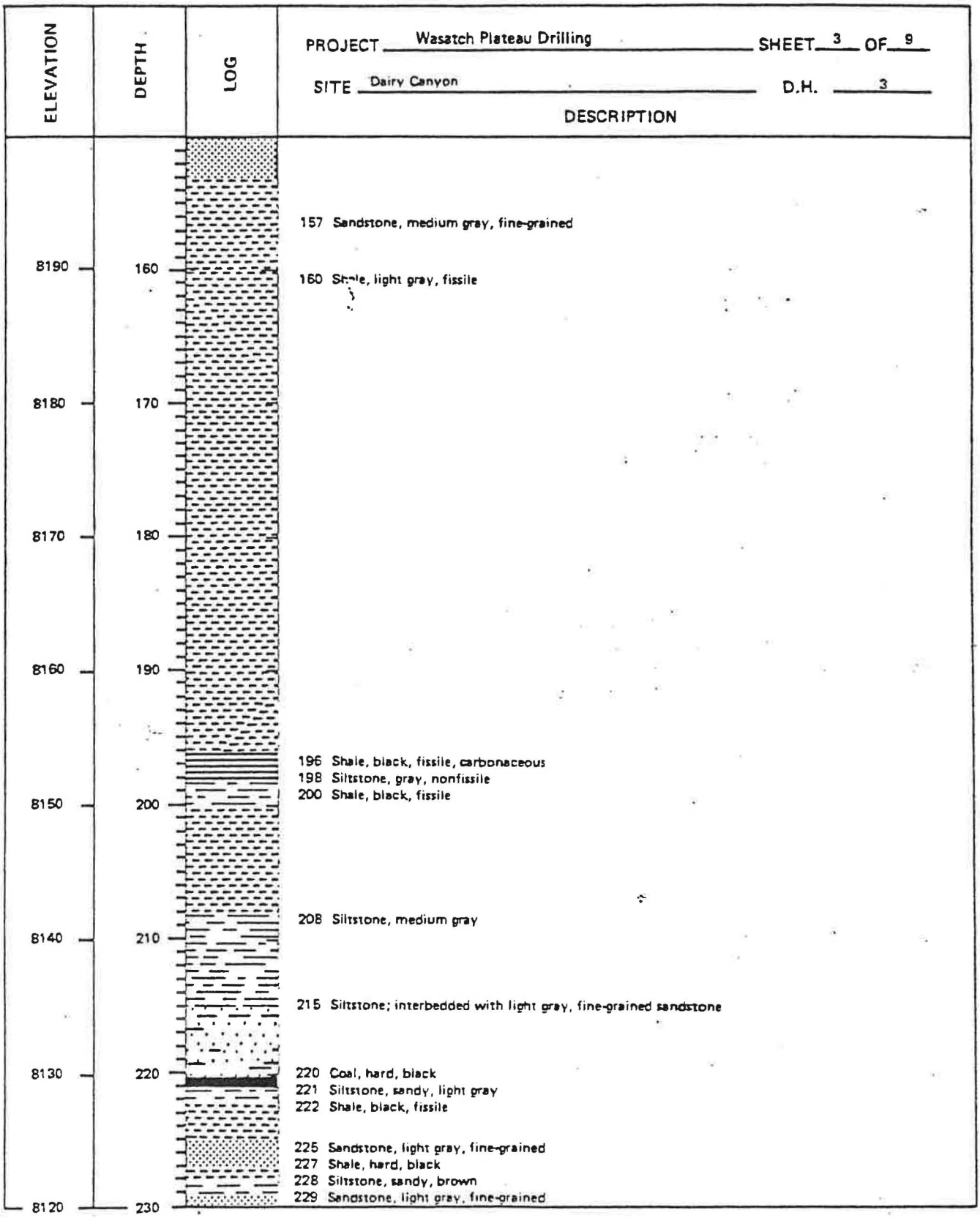
HOLE LOGGED BY F. Davis, L. Green, J. Call DRILLER Boyles Brothers DRILL HOLE 3



PROJECT Wasatch Plateau Drilling SHEET 2 OF 9

SITE Dairy Canyon D.H. 3

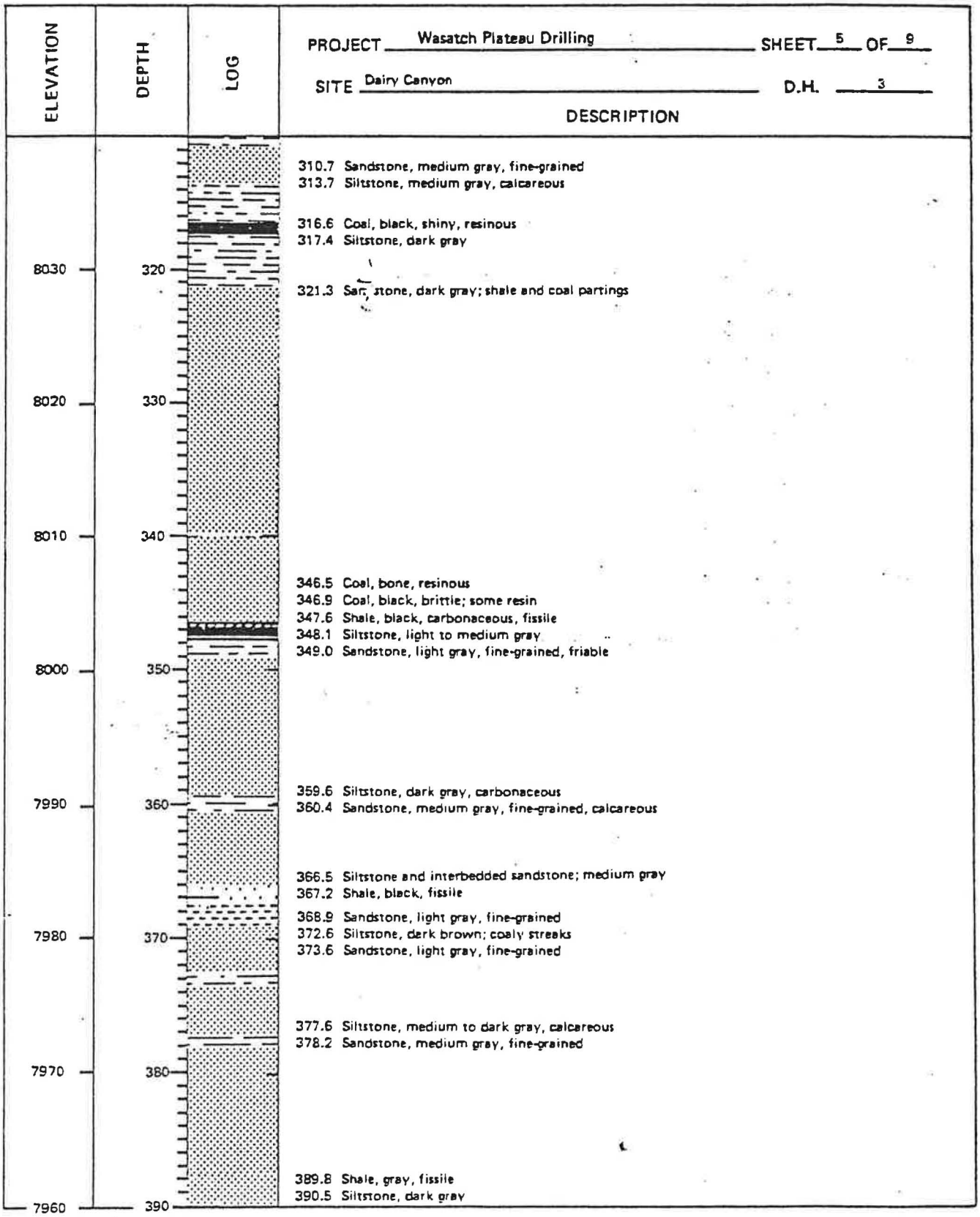
| ELEVATION | DEPTH | LOG | DESCRIPTION |
|---|---|---|---|
| | | | 72 Sandstone boulder, gray, fine-grained |
| 8270 | 80 | | 82 Alluvium: silt, sand and gravel; water entering hole |
| 8260 | 90 | | |
| 8250 | 100 | | |
| 8240 | 110 | | |
| 8230 | 120 | | 120 Shale, gray, fissile |
| 8220 | 130 | | 129 Sandstone, tan, fine-grained, water-saturated; artesian flow of 150 gallon/minute |
| 8210 | 140 | | 143 Shale, gray, fissile |
| | | | 145 Coal |
| | | | 146 Shale, gray, fissile |
| 8200 | 150 | | |

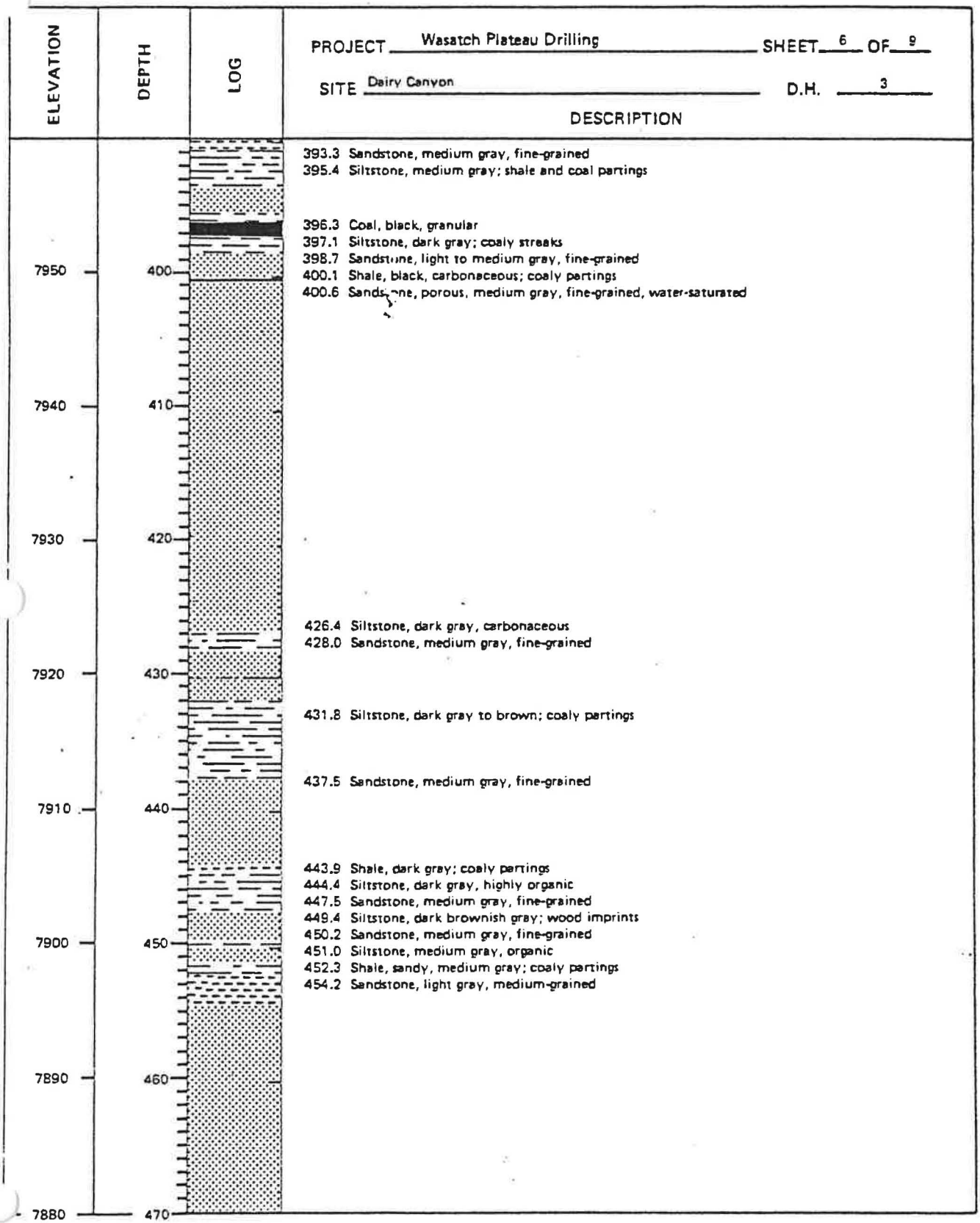

ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 3 OF 9
SITE Dairy Canyon
D.H. 3
DESCRIPTION
157 Sandstone, medium gray, fine-grained
160 Shale, light gray, fissile
196 Shale, black, fissile, carbonaceous
198 Siltstone, gray, nonfissile
200 Shale, black, fissile
208 Siltstone, medium gray
215 Siltstone; interbedded with light gray, fine-grained sandstone
220 Coal, hard, black
221 Siltstone, sandy, light gray
222 Shale, black, fissile
225 Sandstone, light gray, fine-grained
227 Shale, hard, black
228 Siltstone, sandy, brown
229 Sandstone, light gray, fine-grained
8190
8180
8170
8160
8150
8140
8130
8120
160
170
180
190
200
210
220
230

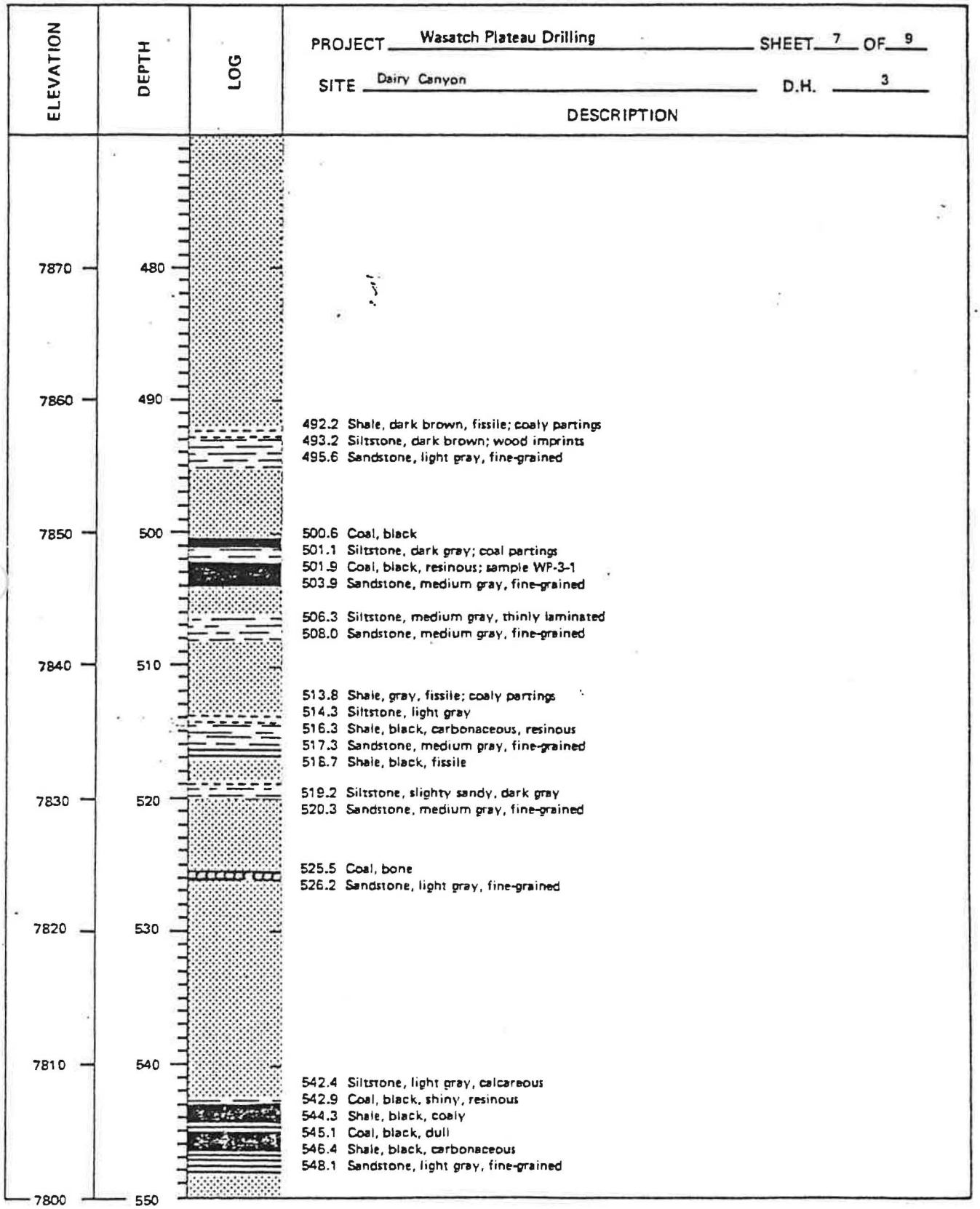
PROJECT Wasatch Plateau Drilling SHEET 4 OF 9

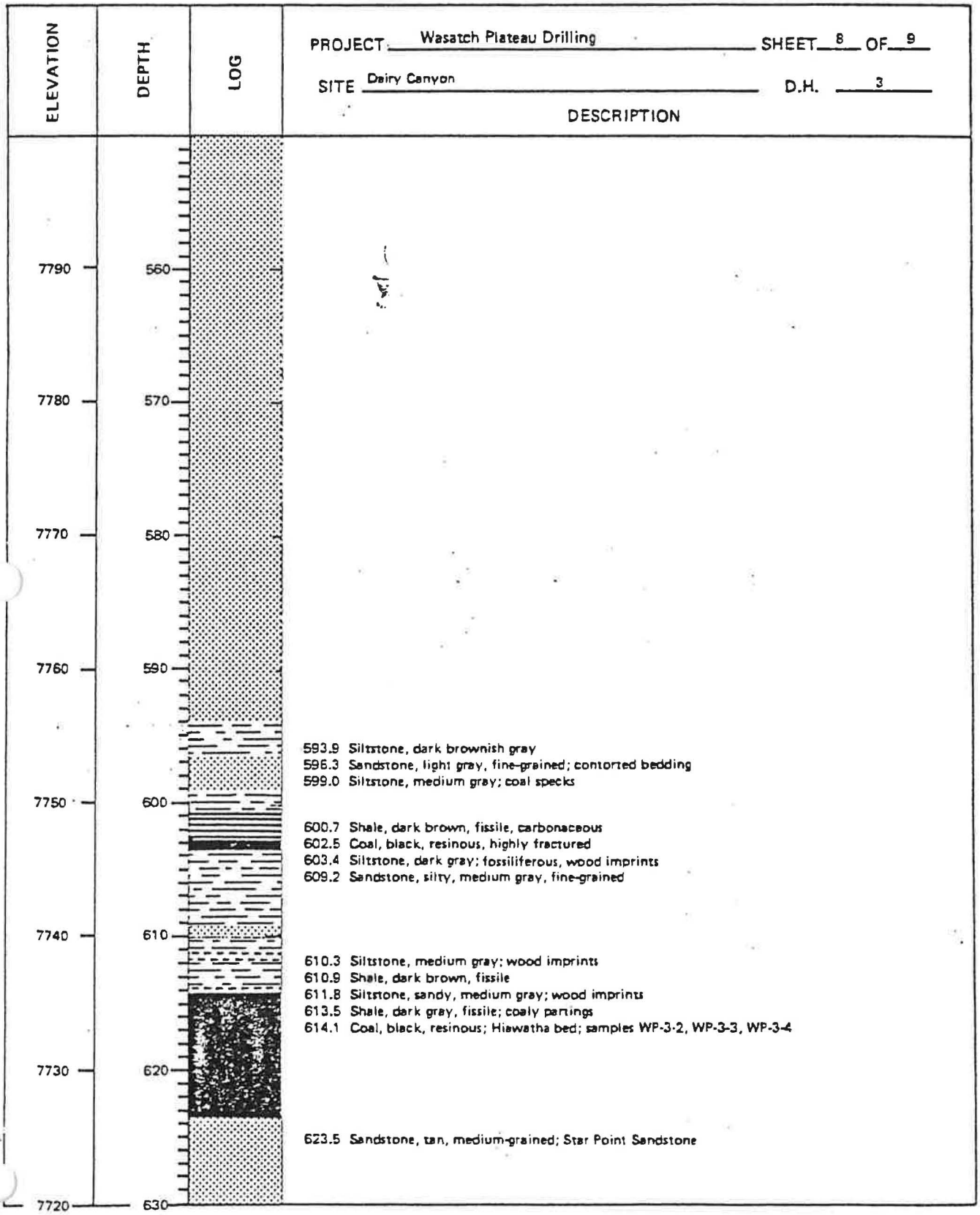
SITE Dairy Canyon D.H. 3

| ELEVATION | DEPTH | LOG | DESCRIPTION |
|---|---|---|---|
| | | | 231 Shale, dark gray, fissile |
| | | | 233 Siltstone, light gray |
| | | | 236 Shale, dark gray, fissile |
| | | | 238 Siltstone, dark brown |
| 8110 | 240 | | 240 Sandstone, light gray, fine-grained |
| | | | 244 Shale, dark gray, fissile |
| | | | 246 Siltstone, light gray |
| | | | 248 Shale, dark gray, fissile |
| 8100 | 250 | | 250 Sandstone, light gray, fine-grained |
| | | | 255 Shale, dark gray, fissile |
| 8090 | 260 | | 264 Sandstone, light gray, fine-grained |
| | | | 266 Shale, black, carbonaceous; some coaly specks |
| 8080 | 270 | | 269 Siltstone, gray |
| | | | 271 Sandstone, light gray, fine-grained; coal specks |
| | | | 273 Shale, dark gray, fissile |
| | | | 278 Sandstone, light gray |
| 8070 | 280 | | 280 Siltstone, slightly sandy, light gray |
| | | | 282 Sandstone, light gray, fine-grained |
| | | | 284 Siltstone, light gray |
| 8060 | 290 | | 290 Sandstone, light gray, fine-grained |
| | | | 292 Shale, dark gray to black, fissile |
| | | | 294 Siltstone, slightly sandy, light gray |
| | | | 296 Shale, black, fissile |
| 8050 | 300 | | 300.0 Coring began |
| | | | 300.3 Siltstone, medium gray, fossiliferous |
| | | | 303.4 Coal, black, brittle, fractured |
| | | | 304.1 Coal, bone |
| | | | 304.5 Siltstone, dark gray |
| | | | 305.2 Sandstone, light gray, fine-grained |
| | | | 306.7 Siltstone, medium gray, calcareous |
| | | | 308.6 Sandstone, light gray, fine-grained |
| 40 | 310 | | 309.9 Siltstone, soft, dark gray |


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 5 OF 9
SITE Dairy Canyon
D.H. 3
DESCRIPTION
8030
8020
8010
8000
7990
7980
7970
7960
320
330
340
350
360
370
380
390
310.7 Sandstone, medium gray, fine-grained
313.7 Siltstone, medium gray, calcareous
316.6 Coal, black, shiny, resinous
317.4 Siltstone, dark gray
321.3 Sandstone, dark gray; shale and coal partings
346.5 Coal, bone, resinous
346.9 Coal, black, brittle; some resin
347.6 Shale, black, carbonaceous, fissile
348.1 Siltstone, light to medium gray
349.0 Sandstone, light gray, fine-grained, friable
359.6 Siltstone, dark gray, carbonaceous
360.4 Sandstone, medium gray, fine-grained, calcareous
366.5 Siltstone and interbedded sandstone; medium gray
367.2 Shale, black, fissile
368.9 Sandstone, light gray, fine-grained
372.6 Siltstone, dark brown; coaly streaks
373.6 Sandstone, light gray, fine-grained
377.6 Siltstone, medium to dark gray, calcareous
378.2 Sandstone, medium gray, fine-grained
389.8 Shale, gray, fissile
390.5 Siltstone, dark gray


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 6 OF 9
SITE Dairy Canyon
D.H. 3
DESCRIPTION
393.3 Sandstone, medium gray, fine-grained
395.4 Siltstone, medium gray; shale and coal partings
396.3 Coal, black, granular
397.1 Siltstone, dark gray; coaly streaks
398.7 Sandstone, light to medium gray, fine-grained
400.1 Shale, black, carbonaceous; coaly partings
400.6 Sandstone, porous, medium gray, fine-grained, water-saturated
426.4 Siltstone, dark gray, carbonaceous
428.0 Sandstone, medium gray, fine-grained
431.8 Siltstone, dark gray to brown; coaly partings
437.5 Sandstone, medium gray, fine-grained
443.9 Shale, dark gray; coaly partings
444.4 Siltstone, dark gray, highly organic
447.5 Sandstone, medium gray, fine-grained
449.4 Siltstone, dark brownish gray; wood imprints
450.2 Sandstone, medium gray, fine-grained
451.0 Siltstone, medium gray, organic
452.3 Shale, sandy, medium gray; coaly partings
454.2 Sandstone, light gray, medium-grained
7950
7940
7930
7920
7910
7900
7890
7880
400
410
420
430
440
450
460
470


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 7 OF 9
SITE Dairy Canyon
D.H. 3
DESCRIPTION
7870
480
7860
490
492.2 Shale, dark brown, fissile; coaly partings
493.2 Siltstone, dark brown; wood imprints
495.6 Sandstone, light gray, fine-grained
7850
500
500.6 Coal, black
501.1 Siltstone, dark gray; coal partings
501.9 Coal, black, resinous; sample WP-3-1
503.9 Sandstone, medium gray, fine-grained
506.3 Siltstone, medium gray, thinly laminated
508.0 Sandstone, medium gray, fine-grained
7840
510
513.8 Shale, gray, fissile; coaly partings
514.3 Siltstone, light gray
516.3 Shale, black, carbonaceous, resinous
517.3 Sandstone, medium gray, fine-grained
518.7 Shale, black, fissile
7830
520
519.2 Siltstone, slighty sandy, dark gray
520.3 Sandstone, medium gray, fine-grained
525.5 Coal, bone
526.2 Sandstone, light gray, fine-grained
7820
530
7810
540
542.4 Siltstone, light gray, calcareous
542.9 Coal, black, shiny, resinous
544.3 Shale, black, coaly
545.1 Coal, black, dull
546.4 Shale, black, carbonaceous
548.1 Sandstone, light gray, fine-grained
7800
550


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 8 OF 9
SITE Dairy Canyon
D.H. 3
DESCRIPTION
7790
560
7780
570
7770
580
7760
590
7750
600
7740
610
7730
620
7720
630
593.9 Siltstone, dark brownish gray
596.3 Sandstone, light gray, fine-grained; contorted bedding
599.0 Siltstone, medium gray; coal specks
600.7 Shale, dark brown, fissile, carbonaceous
602.5 Coal, black, resinous, highly fractured
603.4 Siltstone, dark gray; fossiliferous, wood imprints
609.2 Sandstone, silty, medium gray, fine-grained
610.3 Siltstone, medium gray; wood imprints
610.9 Shale, dark brown, fissile
611.8 Siltstone, sandy, medium gray; wood imprints
613.5 Shale, dark gray, fissile; coaly partings
614.1 Coal, black, resinous; Hiawatha bed; samples WP-3-2, WP-3-3, WP-3-4
623.5 Sandstone, tan, medium-grained; Star Point Sandstone

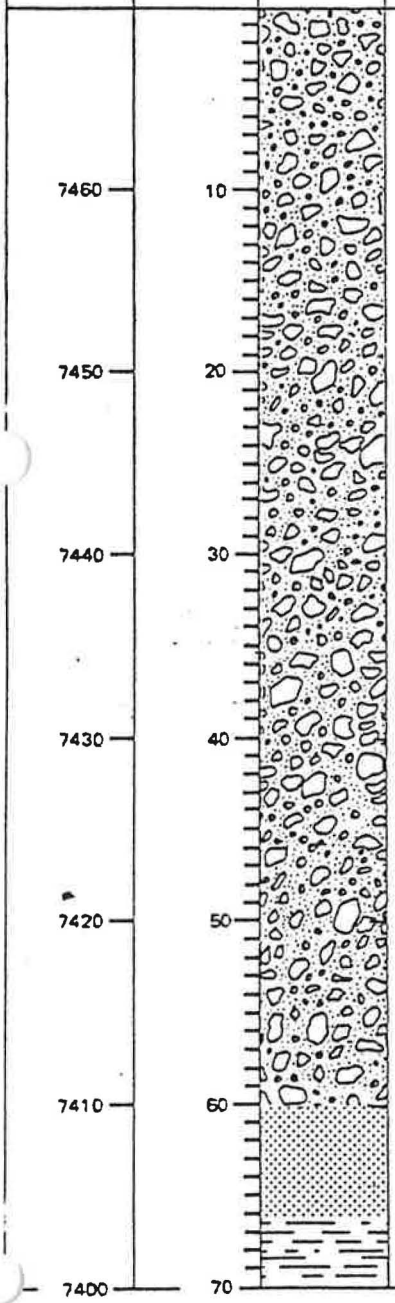
| ELEVATION | DEPTH | LOG | PROJECT Wasatch Plateau Drilling SHEET 9 OF 9<br>SITE Dairy Canyon D.H. 3<br>DESCRIPTION |
|---|---|---|---|
| | | | 632.5 Total depth, August 24, 1975 |
| 7710 | 640 | | |

PROJECT Wasatch Plateau Drilling LOCATION SW¼SE¼ sec. 24, T. 17 S., R. 6 E. SHEET 1 OF 5

BEGAN August 5, 1975 COMPLETED August 9, 1975 TOTAL DEPTH OF HOLE 369.6 feet

CORE RECOVERY (%) 100 FEET 210.8 feet GROUND ELEVATION 7,470 feet

HOLE LOGGED BY H. Doelling, F. Davis, L. Green, J. Call DRILLER Boyles Brothers DRILL HOLE No. 4

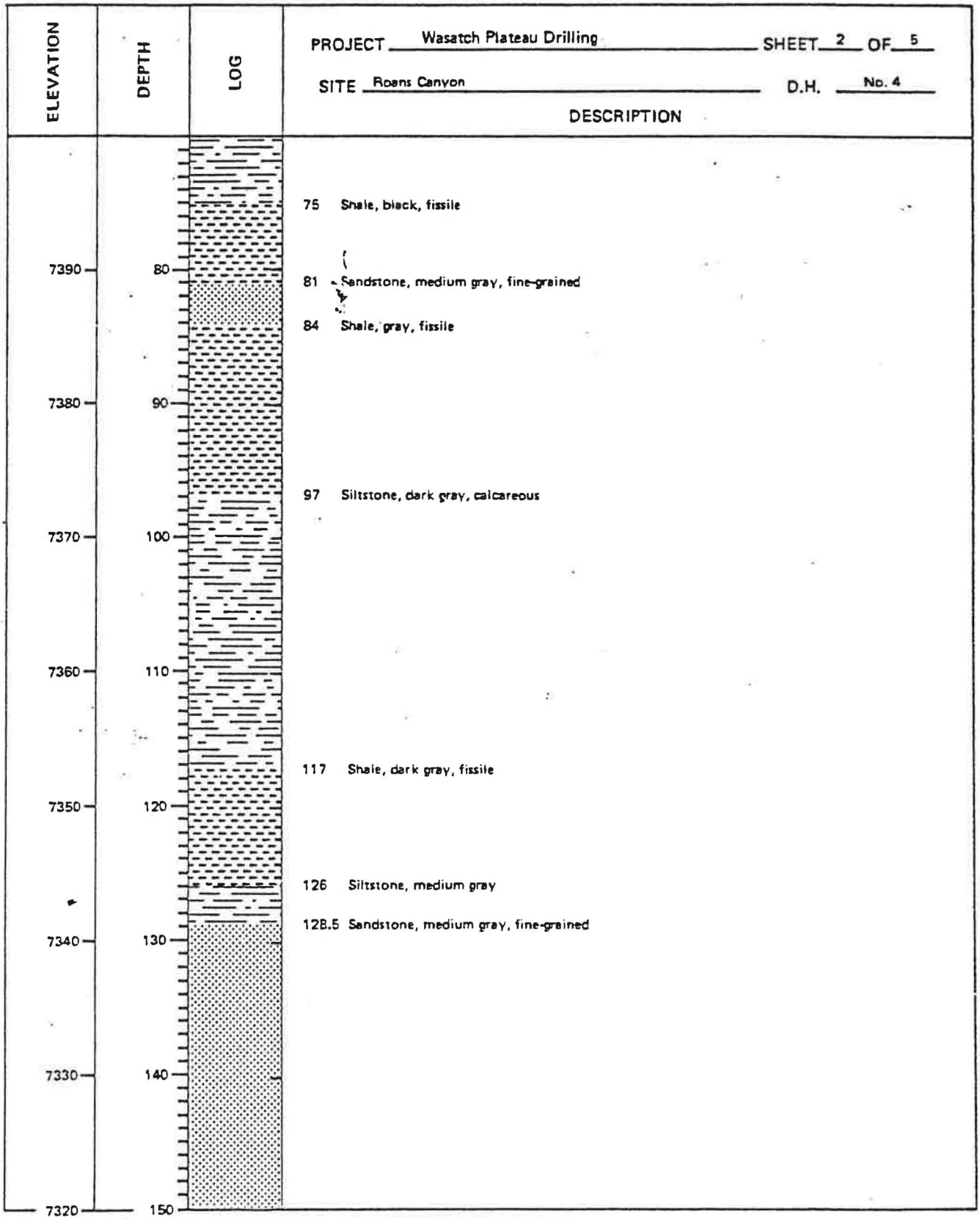


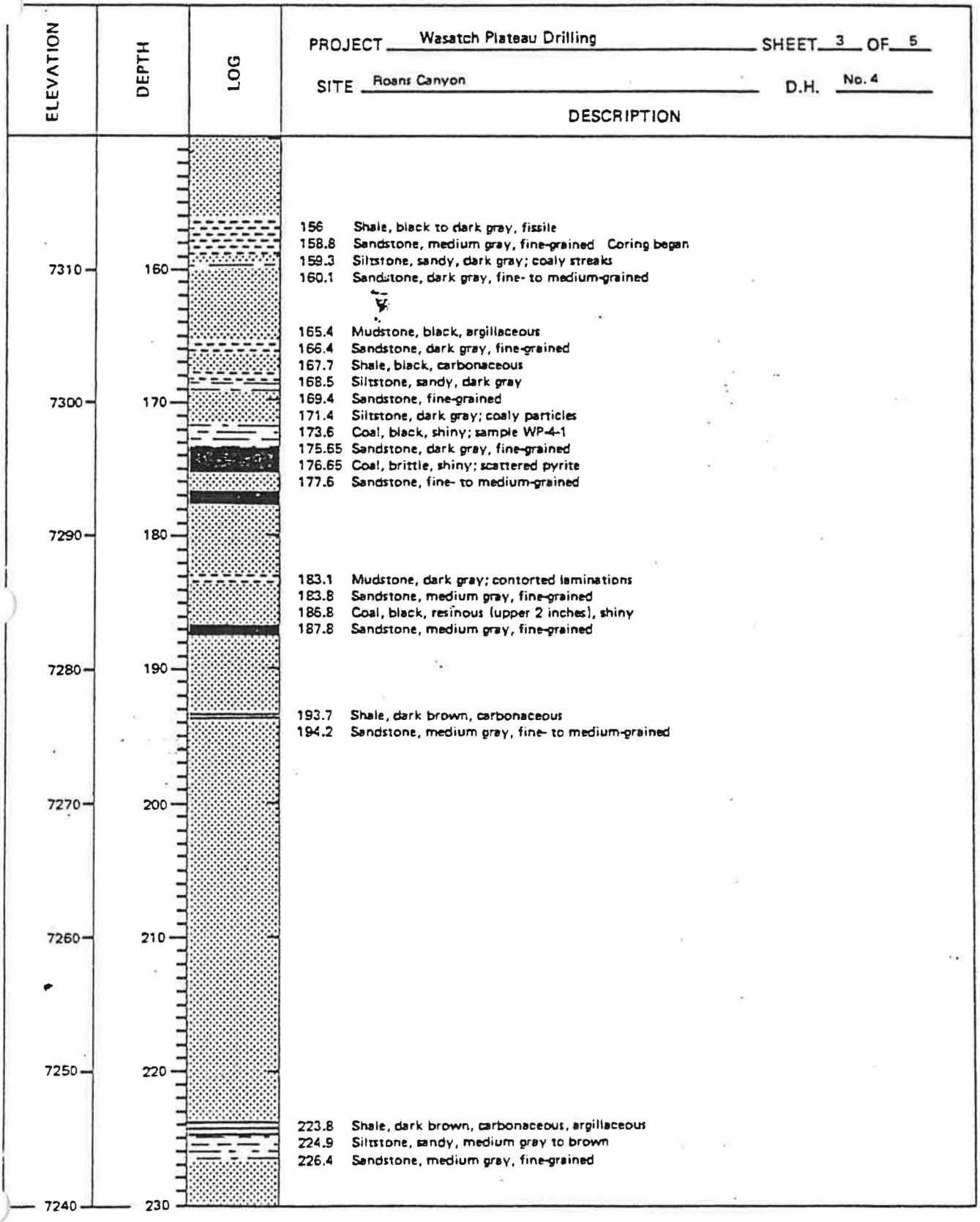

DESCRIPTION

0 Alluvium: silt, sand and gravel

60 Sandstone, tan, medium-grained

67 Siltstone, black


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 2 OF 5
SITE Roans Canyon
D.H. No. 4
DESCRIPTION
75 Shale, black, fissile
81 Sandstone, medium gray, fine-grained
84 Shale, gray, fissile
97 Siltstone, dark gray, calcareous
117 Shale, dark gray, fissile
126 Siltstone, medium gray
128.5 Sandstone, medium gray, fine-grained
7390
7380
7370
7360
7350
7340
7330
7320
80
90
100
110
120
130
140
150


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 3 OF 5
SITE Roans Canyon
D.H. No. 4
DESCRIPTION
7310
160
7300
170
7290
180
7280
190
7270
200
7260
210
7250
220
7240
230
156 Shale, black to dark gray, fissile
158.8 Sandstone, medium gray, fine-grained Coring began
159.3 Siltstone, sandy, dark gray; coaly streaks
160.1 Sandstone, dark gray, fine- to medium-grained
165.4 Mudstone, black, argillaceous
166.4 Sandstone, dark gray, fine-grained
167.7 Shale, black, carbonaceous
168.5 Siltstone, sandy, dark gray
169.4 Sandstone, fine-grained
171.4 Siltstone, dark gray; coaly particles
173.6 Coal, black, shiny; sample WP-4-1
175.65 Sandstone, dark gray, fine-grained
176.65 Coal, brittle, shiny; scattered pyrite
177.6 Sandstone, fine- to medium-grained
183.1 Mudstone, dark gray; contorted laminations
183.8 Sandstone, medium gray, fine-grained
186.8 Coal, black, resinous (upper 2 inches), shiny
187.8 Sandstone, medium gray, fine-grained
193.7 Shale, dark brown, carbonaceous
194.2 Sandstone, medium gray, fine- to medium-grained
223.8 Shale, dark brown, carbonaceous, argillaceous
224.9 Siltstone, sandy, medium gray to brown
226.4 Sandstone, medium gray, fine-grained

PROJECT Wasatch Plateau Drilling SHEET 4 OF 5

SITE Roans Canyon D.H. No. 4

| ELEVATION | DEPTH | LOG | DESCRIPTION |
|---|---|---|---|
| | | | 233.5 Shale, dark brown, carbonaceous |
| | | | 233.9 Sandstone, dark gray to dark brown, fine-grained, carbonaceous |
| 7230 | 240 | | |
| | | | 246.8 Shale, black, carbonaceous, coaly, fissile |
| | | | 247.3 Shale, gray, argillaceous, fissile |
| 7220 | 250 | | 247.8 Siltstone, light brown, fossiliferous |
| | | | 257.9 Sandstone, dark gray, fine-grained; marcasite films |
| | | | 259.4 Siltstone, dense, calcareous; fossil leaves |
| 7210 | 260 | | 260.9 Sandstone, medium gray, fine-grained |
| | | | 267.5 Coal, black, resinous; sample WP-4-2 |
| | | | 268.9 Siltstone; shaly partings; coaly specks |
| 7200 | 270 | | 270.4 Coal, black, resinous; sample WP-4-3 |
| | | | 273.3 Coal, bony, resinous; shaly partings |
| | | | 273.7 Coal, black; not as resinous |
| | | | 274.3 Sandstone, light gray, fine-grained |
| | | | 275.4 Siltstone, dark gray; coaly partings |
| | | | 275.8 Coal, black, resinous |
| | | | 276.9 Sandstone, light gray, fine-grained |
| 7190 | 280 | | |
| 7180 | 290 | | |
| 7170 | 300 | | |
| | | | 307.4 Siltstone, medium to dark gray; marcasite films |
| 7160 | 310 | | |

PROJECT Wasatch Plateau Drilling SHEET 5 OF 5

SITE Roans Canyon D.H. No. 4

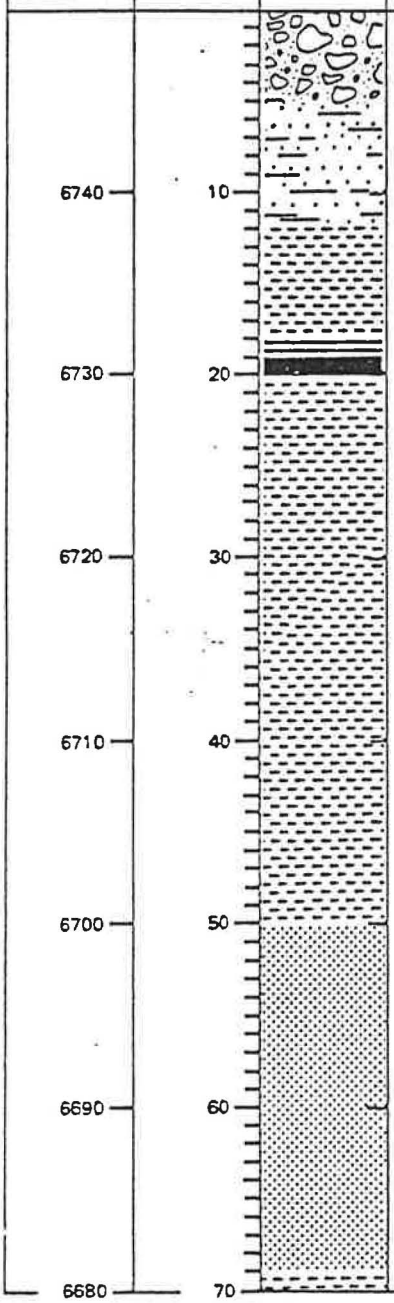
| ELEVATION | DEPTH | LOG | DESCRIPTION |
|---|---|---|---|
| | | | 310.5 Sandstone, light to medium gray, fine-grained |
| | | | 313.0 Coal, bony; coaly streaks |
| | | | 313.4 Shale, carbonaceous, dark brownish black |
| | | | 313.9 Siltstone, medium gray; carbonaceous matter on bedding planes |
| | | | 315.2 Coal, brittle, black, shiny |
| | | | 316.6 Siltstone, medium gray |
| | | | 319.0 Clay, soft, medium gray, gummy, sticky |
| 7150 | 320 | | 320.1 Coal, black, shiny, blocky |
| | | | 320.6 Siltstone, medium gray, carbonaceous |
| 7140 | 330 | | |
| | | | 333.0 Sandstone, medium gray, fine-grained |
| | | | 336.6 Siltstone, medium gray, carbonaceous |
| 7130 | 340 | | |
| | | | 344.3 Sandstone, medium gray, fine-grained |
| | | | 346.6 Coal, black, shiny, blocky; sample WP-4-4 |
| | | | 348.9 Shale, dark gray, carbonaceous, fissile |
| 7120 | 350 | | 349.3 Sandstone, medium gray, fine-grained |
| | | | 351.3 Shale, dark gray, carbonaceous, fissile |
| | | | 352.7 Coal, black, shiny, blocky; samples WP-4-5, WP-4-6, WP-4-7 |
| 7110 | 360 | | |
| | | | 361.6 Siltstone, dark gray, carbonaceous |
| | | | 365.2 Sandstone, tan to dark gray, medium-grained; Star Point Sandstone |
| | | | 369.6 Drilling stopped, August 9, 1975 |
| 7100 | 370 | | Total depth—369.6 feet |

PROJECT Wasatch Plateau Drilling LOCATION SW¼NW¼ sec. 3, T. 18 S., R. 6 E. SHEET 1 OF 6

BEGAN July 7, 1975 COMPLETED July 12, 1975 TOTAL DEPTH OF HOLE 460.0 feet

CORE RECOVERY (%) 100 FEET 200 feet GROUND ELEVATION 6,750 feet

HOLE LOGGED BY H. Doelling, F. Davis, L. Green DRILLER Boyles Brothers DRILL HOLE No. 5




0.0 Alluvium

5.0 Sandstone interbedded with shale

12.0 Shale, gray, fissile

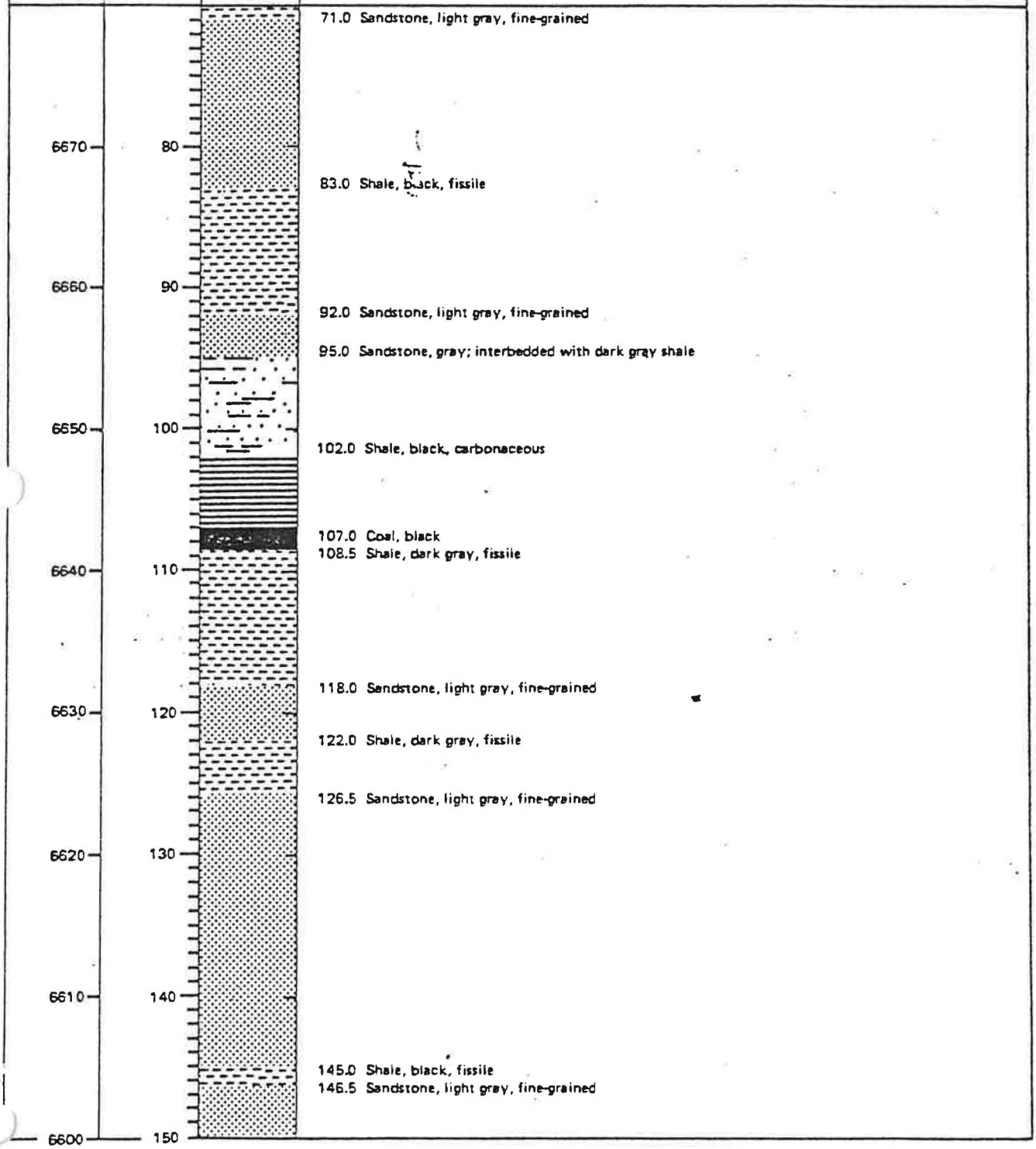
18.0 Shale, dark gray, carbonaceous
19.0 Coal, black
20.0 Shale, light gray, fissile

50.5 Sandstone, light gray, fine-grained, calcareous

69.0 Shale, light gray, fissile

PROJECT Wasatch Plateau Drilling SHEET 2 OF 6

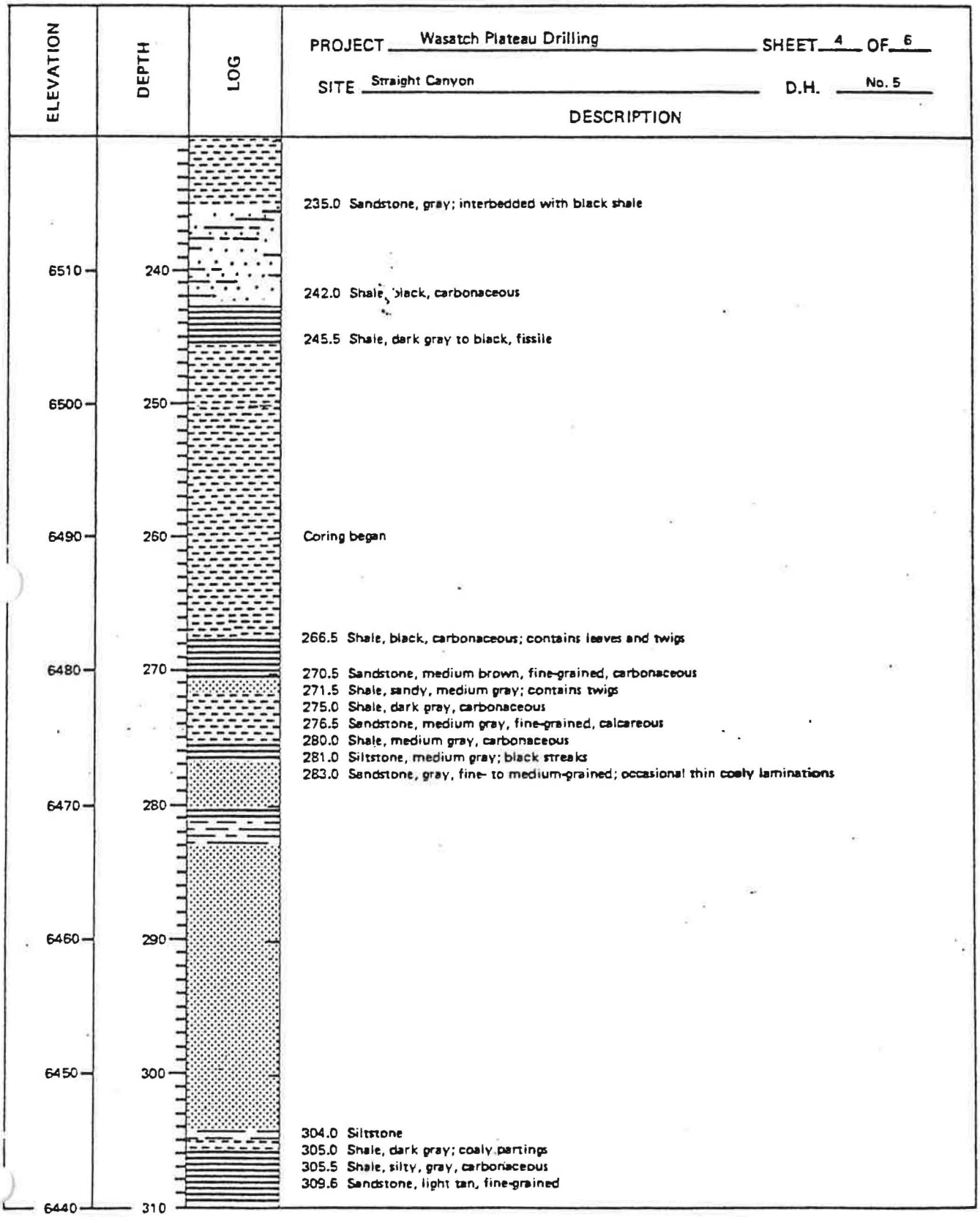
SITE Straight Canyon D.H. No. 5



PROJECT Wasatch Plateau Drilling SHEET 3 OF 6

SITE Straight Canyon D.H. No. 5

| ELEVATION | DEPTH | LOG | DESCRIPTION |
|---|---|---|---|
| | | | 151.0 Shale, black, fissile |
| | | | 158.0 Sandstone, light gray, fine-grained |
| 6590 | 160 | | |
| 6580 | 170 | | |
| 6570 | 180 | | |
| | | | 188.5 Shale, black, fissile |
| 6560 | 190 | | 190.0 Sandstone, light gray, fine-grained |
| | | | 194.0 Shale, black, fissile |
| | | | 197.0 Sandstone, light gray, fine-grained |
| 6550 | 200 | | |
| | | | 202.0 Shale, black, fissile |
| | | | 206.0 Coal, black |
| | | | 207.0 Sandstone, light gray, fine-grained |
| 6540 | 210 | | |
| | | | 211.0 Shale, dark gray to black |
| 6530 | 220 | | |
| | | | 222.0 Sandstone, gray, thin |
| | | | 223.0 Shale, dark gray to black |
| 6520 | 230 | | |


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 4 OF 6
SITE Straight Canyon
D.H. No. 5
DESCRIPTION
6510
240
6500
250
6490
260
6480
270
6470
280
6460
290
6450
300
6440
310
235.0 Sandstone, gray; interbedded with black shale
242.0 Shale, black, carbonaceous
245.5 Shale, dark gray to black, fissile
Coring began
266.5 Shale, black, carbonaceous; contains leaves and twigs
270.5 Sandstone, medium brown, fine-grained, carbonaceous
271.5 Shale, sandy, medium gray; contains twigs
275.0 Shale, dark gray, carbonaceous
276.5 Sandstone, medium gray, fine-grained, calcareous
280.0 Shale, medium gray, carbonaceous
281.0 Siltstone, medium gray; black streaks
283.0 Sandstone, gray, fine- to medium-grained; occasional thin coaly laminations
304.0 Siltstone
305.0 Shale, dark gray; coaly partings
305.5 Shale, silty, gray, carbonaceous
309.6 Sandstone, light tan, fine-grained

PROJECT Wasatch Plateau Drilling SHEET 5 OF 6

SITE Straight Canyon D.H. No. 5

| ELEVATION | DEPTH | LOG | DESCRIPTION |
|---|---|---|---|
| | | | 312.0 Shale, silty, dark gray; leaf imprints |
| | | | 313.5 Siltstone, medium gray; coaly fragments |
| | | | 317.4 Sandstone, tan to gray, fine-grained; carbonaceous layers |
| 6430 | 320 | | |
| 6420 | 330 | | 330.4 Coal, brittle, black, pyritic |
| | | | 330.9 Sandstone, medium gray, fine-grained |
| | | | 333.6 Coal: 333.6—bony; 333.65—resinous; 334.2—not as resinous |
| | | | 335.2 Sandstone, medium gray, fine-grained |
| | | | 337.5 Siltstone, medium gray; organic debris |
| 6410 | 340 | | 339.0 Shale, medium gray to black; stem and leaf imprints |
| | | | 340.5 Shale, medium gray to black, carbonaceous; occasional thin coal seams |
| | | | 342.1 Siltstone, medium gray; stem imprints |
| | | | 344.8 Sandstone, light gray, fine-grained |
| | | | 346.4 Siltstone, medium gray; leaf and stem imprints |
| | | | 348.8 Sandstone interbedded with siltstone; medium gray; occasional shaly layers |
| 6400 | 350 | | |
| 6390 | 360 | | 359.1 Siltstone, medium gray; leaf imprints |
| | | | 362.3 Shale, gray to black, coaly and carbonaceous |
| | | | 363.6 Sandstone, medium gray, fine-grained |
| | | | 364.2 Shale, dark gray to black; a few coaly partings |
| | | | 365.2 Siltstone, medium gray; organic matter |
| 6380 | 370 | | 370.9 Sandstone, medium gray, fine-grained; occasional thin layers of siltstone and shale |
| 6370 | 380 | | |
| 6360 | 390 | | 389.8 Siltstone, dark gray to black; numerous coaly shale partings |

PROJECT Wasatch Plateau Drilling SHEET 6 OF 6

SITE Straight Canyon D.H. No. 5

| ELEVATION | DEPTH | LOG | DESCRIPTION |
|---|---|---|---|
| | | | 392.6 Sandstone, medium gray, fine-grained |
| 6350 | 400 | | |
| | | | 403.1 Shale, sandy, light gray |
| | | | 403.6 Sandstone, light gray, fine-grained |
| | | | 407.6 Siltstone, light gray |
| 6340 | 410 | | 408.1 Sandstone, light gray, fine-grained; some coal imprints on bedding planes |
| | | | 416.3 Siltstone, medium gray to black; shaly partings; leaf and stem imprints |
| 6330 | 420 | | |
| | | | 421.9 Shale, black; bony coal streaks |
| | | | 423.1 Sandstone, medium gray, fine-grained; leaf and stem imprints |
| 6320 | 430 | | |
| 6310 | 440 | | |
| | | | 443.6 Coal, hard, black; Hiawatha coal bed |
| 6300 | 450 | | |
| | | | 450.9 Coal, bony |
| | | | 451.1 Siltstone, medium gray |
| | | | 452.4 Shale, dark gray; specks of coal |
| | | | 453.9 Sandstone, light gray, medium- to coarse-grained; Star Point Sandstone |
| | | | 460.0 Total depth |
| 6290 | 460 | | |

# APPENDIX 6-2

# ROOF AND FLOOR ANALYSES

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 6-2

# ROOF AND FLOOR ANALYSES

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Member of the SGS Group (Société Générale de Surveillance)

PLEASE ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1020, HUNTINGTON, UT 84528
TELEPHONE: (801) 653-2311

Beaver Creek Coal Co.
P.O. Box 1378
Price, UT 84501

Jan. 8, 1990

Sample identification by Beaver Creek

| | | |
|---|---|---|
| Kind of sample reported to us | Soil | |
| Sample taken at | Beaver Creek | Floor - Main - North |
| Sample taken by | Beaver Creek | |
| Date sampled | ---------- | |
| Date received | Dec. 6, 1989 | |

Analysis report no. 59-108706 p. 1

| | |
|---|---|
| pH | 7.7 units |
| Electrical Conductivity | 0.88 mmhos/cm |
| Saturation Percent | 17.1% |
| Sodium Adsorption Ratio | 0.76 |
| Soluble calcium | 1.16 meq/l |
| Soluble magnesium | 1.67 meq/l |
| Soluble sodium | 0.91 meq/l |
| Particle size analysis: | |
| Sand | 77.8% |
| Silt | 13.8% |
| Clay | 8.4% |
| Selenium (total available) | <0.1 mg/kg |
| Total Nitrogen | 0.29% |
| Nitrate nitrogen | 0.02 mg/kg |
| Boron (total available) | 0.1 mg/kg |

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Manager, Huntington Laboratory

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TELEPHONE: (801) 653-2311

Beaver Creek Coal Co.
P.O. Box 1378
Price, UT 84501

Jan. 8, 1990

Sample identification by Beaver Creek

| | |
|---|---|
| Kind of sample reported to us | Soil |
| Sample taken at | Beaver Creek — Floor - Main - North |
| Sample taken by | Beaver Creek |
| Date sampled | ---------- |
| Date received | Dec. 6, 1989 |

Analysis report no. 59-108706 p.2

| | |
|---|---|
| Neutralization Potential | 1.4 tons $CaCO_3$ / 1000 tons |
| Maximum Acid Potential* | 3.8 tons $CaCO_3$ / 1000 tons |
| Acid Base Account | -2.4 tons $CaCO_3$ / 1000 tons |

(*acid potential based on non-sulfate sulfur)

| | |
|---|---|
| Organic Carbon | 9.5% |
| Rock fragments | 98.5% |
| Available water capacity* | 2.80% |

(*by ASTM D-1412; USDA procedure not available)

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TELEPHONE: (801) 653-2311

Beaver Creek Coal Co.
P.O. Box 1378
Price, UT 84501

Jan. 8, 1990

Sample identification by Beaver Creek

| | | |
|---|---|---|
| Kind of sample reported to us | Soil | |
| Sample taken at | Beaver Creek | Roof - Main - North |
| Sample taken by | Beaver Creek | |
| Date sampled | ---------- | |
| Date received | Dec. 6, 1989 | |

Analysis report no. 59-108704 p. 1

| | |
|---|---|
| pH | 8.8 units |
| Electrical Conductivity | 1.34 mmhos/cm |
| Saturation Percent | 19.9% |
| Sodium Adsorption Ratio | 5.37 |
| Soluble calcium | 1.73 meq/l |
| Soluble magnesium | 2.68 meq/l |
| Soluble sodium | 7.98 meq/l |
| Particle size analysis: | |
| Sand | 89.8% |
| Silt | 7.3% |
| Clay | 2.9% |
| Selenium (total available) | <0.1 mg/kg |
| Total Nitrogen | 0.48% |
| Nitrate nitrogen | 0.11 mg/kg |
| Boron (total available) | 0.5 mg/kg |

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TELEPHONE: (801) 653-2311

Beaver Creek Coal Co.
P.O. Box 1378
Price, UT 84501

Jan. 8, 1990

Sample identification by Beaver Creek

| | |
|---|---|
| Kind of sample reported to us | Soil |
| Sample taken at | Beaver Creek — Roof - Main - North |
| Sample taken by | Beaver Creek |
| Date sampled | ---------- |
| Date received | Dec. 6, 1989 |

Analysis report no. 59-108704 p.2

| | |
|---|---|
| Neutralization Potential | 98.2 tons $CaCO_3$ / 1000 tons |
| Maximum Acid Potential* | 16.2 tons $CaCO_3$ / 1000 tons |
| Acid Base Account | 82.0 tons $CaCO_3$ / 1000 tons |

(*acid potential based on non-sulfate sulfur)

| | |
|---|---|
| Organic Carbon | 7.5% |
| Rock fragments | 98.3% |
| Available water capacity* | 3.90% |

(*by ASTM D-1412; USDA procedure not available)

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TELEPHONE: (801) 653-2311

BEAVER CREEK COAL CO.
P.O. Box 1378
Price, UT 84501

Dec. 22, 1989

Sample identification by

| | |
|---|---|
| Kind of sample reported to us | Coal |
| Sample taken at | Trail Mountain |
| Sample taken by | Trail Mountain |
| Date sampled | Nov. 28, 1989 |
| Date received | Dec. 6, 1989 |

TRAIL MOUNTAIN
NO. 9 Mine
North-Main-Coal

Analysis report no. 59-108708

FORMS OF SULFUR

| | As Rec'd | Dry |
|---|---|---|
| Sulfate | 0.00 | 0.00 |
| Pyritic | 0.38 | 0.40 |
| Organic | 0.03 | 0.03 |
| Total | 0.41 | 0.43 |

Marcasite (FeS2) Content - 0.71%

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PLEASE ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1020, HUNTINGTON, UT 84528
TELEPHONE: (801) 653-2311

December 22, 1989

Job No.: 59 108708

Date Rec'd: December 6, 1989

Date Sampled: November 28, 1989

Sampled By: BEAVER CREEK

Sample ID:

NORTH-MAIN-COAL
1 Bag (dry)
28.5 lbs.

Beaver Creek Coal Co.
P.O. Box 1378
Price Utah 84501

---

PROXIMATE ANALYSIS OF COAL

---

| | %Moisture | %Ash | %Volatile | %Fixed Carbon | Btu/lb | %Sulfur |
|---|---|---|---|---|---|---|
| As Rec'd | 4.53 | 11.40 | xxxxx | xxxxx | 12238 | 0.41 |
| Dry Basis | | 11.94 | xxxxx | xxxxx | 12819 | 0.43 |
| M-A-Free | | | | | 14557 | |

% AIR DRY MOISTURE LOSS: 2.42

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TELEPHONE: (801) 653-2311

Beaver Creek Coal Co.
P.O. Box 1378
Price, UT 84501

Jan. 8, 1990

Sample identification by Beaver Creek

| | |
|---|---|
| Kind of sample reported to us | Soil |
| Sample taken at | Beaver Creek 2nd Left - Roof |
| Sample taken by | Beaver Creek |
| Date sampled | Nov. 28, 1989 |
| Date received | Dec. 6, 1989 |

Analysis report no. 59-108705 p. 1

| | |
|---|---|
| pH | 8.8 units |
| Electrical Conductivity | 1.74 mmhos/cm |
| Saturation Percent | 25.2% |
| Sodium Adsorption Ratio | 21.1 |
| Soluble calcium | 0.43 meq/l |
| Soluble magnesium | 0.44 meq/l |
| Soluble sodium | 13.9 meq/l |
| Particle size analysis: | |
| Sand | 88.7% |
| Silt | 8.1% |
| Clay | 3.2% |
| Selenium (total available) | <0.1 mg/kg |
| Total Nitrogen | 0.58% |
| Nitrate nitrogen | 0.01 mg/kg |
| Boron (total available) | 0.8 mg/kg |

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TELEPHONE: (801) 653-2311

Beaver Creek Coal Co.
P.O. Box 1378
Price, UT 84501

Jan. 8, 1990

Sample identification by Beaver Creek

| | |
|---|---|
| Kind of sample reported to us | Soil |
| Sample taken at | Beaver Creek 2nd Left - Roof |
| Sample taken by | Beaver Creek |
| Date sampled | Nov. 28, 1989 |
| Date received | Dec. 6, 1989 |

Analysis report no. 59-108705 p.2

| | |
|---|---|
| Neutralization Potential | 98.2 tons $CaCO_3$ / 1000 tons |
| Maximum Acid Potential* | 17.8 tons $CaCO_3$ / 1000 tons |
| Acid Base Account | 80.4 tons $CaCO_3$ / 1000 tons |

(*acid potential based on non-sulfate sulfur)

| | |
|---|---|
| Organic Carbon | 11.5% |
| Rock fragments | 98.0% |
| Available water capacity* | 3.90% |

(*by ASTM D-1412; USDA procedure not available)

| | |
|---|---|
| Exchangeable Sodium Percentage | 23.0% |

Respectfully submitted,
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TELEPHONE: (801) 653-2311


Beaver Creek Coal Co.
P.O. Box 1378
Price, UT 84501

Jan. 8, 1990

Sample identification by Beaver Creek

| | |
|---|---|
| Kind of sample reported to us | Soil |
| Sample taken at | Beaver Creek — 2nd Left - Floor |
| Sample taken by | Beaver Creek |
| Date sampled | Nov. 28, 1989 |
| Date received | Dec. 6, 1989 |

Analysis report no. 59-108707 p. 1

| | |
|---|---|
| pH | 6.5 units |
| Electrical Conductivity | 2.35 mmhos/cm |
| Saturation Percent | 29.4% |
| Sodium Adsorption Ratio | 1.43 |
| Soluble calcium | 8.77 meq/l |
| Soluble magnesium | 6.14 meq/l |
| Soluble sodium | 3.91 meq/l |
| Particle size analysis: | |
| Sand | 82.6% |
| Silt | 12.3% |
| Clay | 5.1% |
| Selenium (total available) | <0.1 mg/kg |
| Total Nitrogen | 0.71% |
| Nitrate nitrogen | 0.02 mg/kg |
| Boron (total available) | 0.6 mg/kg |

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TELEPHONE: (801) 653-2311

Beaver Creek Coal Co.
P.O. Box 1378
Price, UT 84501

Jan. 8, 1990

Sample identification by Beaver Creek

| | |
|---|---|
| Kind of sample reported to us | Soil |
| Sample taken at | Beaver Creek 2nd Left - Floor |
| Sample taken by | Beaver Creek |
| Date sampled | Nov. 28, 1989 |
| Date received | Dec. 6, 1989 |

Analysis report no. 59-108707 p.2

| | |
|---|---|
| Neutralization Potential | 3.0 tons $CaCO_3$ / 1000 tons |
| Maximum Acid Potential* | 84.7 tons $CaCO_3$ / 1000 tons |
| Acid Base Account | -81.7 tons $CaCO_3$ / 1000 tons |

(*acid potential based on non-sulfate sulfur)

| | |
|---|---|
| Organic Carbon | 37.3% |
| Rock fragments | 99.1% |
| Available water capacity* | 3.70% |

(*by ASTM D-1412; USDA procedure not available)

Respectfully submitted,
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TELEPHONE: (801) 653-2311

BEAVER CREEK COAL CO.
P.O. Box 1378
Price, UT 84501

Dec. 22, 1989

Sample identification by

TRAIL MOUNTAIN
NO. 9 Mine
Second Left - Coal

| | |
|---|---|
| Kind of sample reported to us | Coal |
| Sample taken at | Trail Mountain |
| Sample taken by | Trail Mountain |
| Date sampled | Nov. 28, 1989 |
| Date received | Dec. 6, 1989 |

Analysis report no. 59-108709

## FORMS OF SULFUR

| | As Rec'd | Dry |
|---|---|---|
| Sulfate | 0.00 | 0.00 |
| Pyritic | 0.17 | 0.18 |
| Organic | 0.41 | 0.42 |
| Total | 0.58 | 0.60 |

Marcasite ($FeS_2$) Content - 0.32%

Respectfully submitted,
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PLEASE ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1020, HUNTINGTON, UT 84528
TELEPHONE: (801) 653-2311

December 22, 1989

Job No.: 59 108709

Date Rec'd: December 6, 1989

Date Sampled: November 28, 1989

Sampled By: BEAVER CREEK

Sample ID:

2nd LEFT-COAL
1 Bag (dry)
27.75 lbs.

Beaver Creek Coal Co.
P.O. Box 1378
Price Utah 84501

---

PROXIMATE ANALYSIS OF COAL

---

| | %Moisture | %Ash | %Volatile | %Fixed Carbon | Btu/lb | %Sulfur |
|---|---|---|---|---|---|---|
| As Rec'd | 4.46 | 12.18 | xxxxx | xxxxx | 12121 | 0.57 |
| Dry Basis | | 12.75 | xxxxx | xxxxx | 12687 | 0.60 |
| M-A-Free | | | | | 14541 | |

% AIR DRY MOISTURE LOSS: 2.07

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# CHAPTER 7
# HYDROLOGY

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# CHAPTER 7
# HYDROLOGY

## 710 Groundwater Hydrology

### 711 General Requirements

Information used in preparing the groundwater hydrologic section has been gathered by field investigations conducted on the ground and in the mine. Water quality samples have been collected and analyzed. Pertinent literature has been examined. In addition, experience of personnel working in the mine has been utilized to obtain estimates of the quantity of water encountered in the mine. Fossil Rock has leased the Cottonwood Tract Lease, although this lease will not be mined until permitted by the Division, baseline information associated with the lease is provided in this chapter.

### 712 Certification

Maps, plans, and cross sections presented in this chapter have been certified by a qualified, registered professional engineer.

### 713 Inspection

Impoundments associated with the mining and reclamation operations will be inspected as described in Section 514, 515 and 532 of this M&RP.

## 720 Environmental Description

### 721 General Requirements

This section presents a description of the pre-mining hydrologic resources within the permit area and adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operation.

## 722 Cross Sections and Maps

### 722.100 Location and Extent of Subsurface Water

The aerial extent of the aquifers is discussed below in Section 724.100. Refer to Plate 6-1 and 7-2.

### 722.200 Location of Surface Water Bodies

Surface water bodies such as streams, lakes, ponds and springs, constructed or natural drainages, and irrigation ditches within the proposed permit and adjacent area are shown on Plate 7-1.

### 722.300 Location of Monitoring Stations

Elevations and locations of monitoring stations used to gather baseline data on water quality and quantity in preparation of the application are shown on Plate 7-2.

### 722.400 Location and Depth of Water Wells

There are no known water wells located in the permit area and adjacent area. Monitoring wells are discussed below.

### 722.500 Surface Topography

Surface topography is shown on Plates 5-2, 5-4 and 7-1.

## 723 Sampling and Analysis

Water samples collected have been analyzed according to methods in either the "Standard Methods for the Examination of Water and Wastewater" or 40 CFR parts 136 and 434. Where feasible, these same references have been used as the basis for sample collection.

## 724 Baseline Information

Surface water, groundwater, and climatic resource information is presented in this section to assist in determining the baseline hydrologic conditions which exist in the area of the mine. This information provides a basis to determine if mining operations have had, or can be expected to have, a significant impact on the hydrologic balance of the area.

A seep and spring survey was conducted on October 29, 1985 in the vicinity of lease UTU-64375 (previously referred to as Tract 2). Data collected from this survey are supplemental to data collected in June 1981 as part of the investigation conducted for leases U-49332, U-082996, ML-22603 (previously referred to as Tract 1).

### 724.100 Groundwater Information

Groundwater - The principal factor controlling the occurrence and availability of groundwater in any area is geology. As noted by Price and Waddell (1973), nearly all of the region surrounding the mine plan area is underlain by rocks of continental and marine origin, consisting predominantly of interbedded sandstones and shales. Although some of the sandstones in the region serve as the principal water-bearing strata, their ability to yield water for extended periods of time is largely controlled by the existence of the relatively impermeable interbedded shale layers, which prevent the downward movement of a significant amount of water.

According to the US Geological Survey (1979), groundwater in the region exists under water table, artesian, and perched conditions. Water table conditions exist primarily in shallow alluvial deposits along larger perennial streams and in relatively flat lying sedimentary rocks. Artesian conditions exist at greater depths where a confining layer overlies a more permeable member; however, pressures are generally not sufficient to produce flowing wells. Perched or impeded conditions exist where the confining layer lies beneath the water-bearing stratum.

As noted by Lines (1985), the Blackhawk Formation and the Star Point Sandstone are considered together in the region as an aquifer. These formations are typically saturated where they exist sufficiently far from the edges of canyons; however, the Blackhawk Formation tends to be drained near the canyons, as was the case in the prior Mine workings.

Strata that overly the Blackhawk Formation are not completely saturated but do contain perched aquifers (Lines, 1985), which provide water locally to springs and base flow to some streams.

Investigations in the vicinity of the Mine by Danielson et al (1981) indicated that most, if not all, groundwater in the region is derived from snowmelt. Recharge tends to be limited in areas underlain by younger rocks due to slope steepness and relative imperviousness, both of which promote runoff rather than infiltration of snowmelt.

The predominant chemical constituents in most springs in the region are calcium, magnesium, and bicarbonate (Lines, 1985). Dissolved solids concentrations generally range from about 250 to 750 milligrams per liter. Regionally, the concentrations of major dissolved constituents in water from individual geologic units are highly variable, due to lithologic complexity in the area.

Spring inventories of the mine plan areas were conducted in 1981 and 1985. The springs within and adjacent to the mine plan areas, shown in Plate 7-1, exist under perched conditions because of the existence of relatively impermeable interbedded shales within the North Horn, Price River, Castlegate and Blackhawk Formations. Springs issue from a sandstone layer underlain by shale adjacent to and downslope from a local recharge basin where more than average snow can accumulate. Recharge zones for these local springs are nearby flats along ridges. Springs generally do not occur along narrow ridges with steep side slopes where little opportunity for groundwater recharge exists.

Another interesting groundwater characteristic deals with the origin of springs with regard to geologic formations. The springs sampled on Trail Mountain were associated with the North Horn Formation. As mentioned previously, the North Horn Formation consists of variegated

shale, sandstone, and thin-bedded limestone. The shale layers act as impeding members to deep percolation, diverting a significant portion of water which percolates through the soil mantle and forcing it to move somewhat horizontally to be discharged at the surface as spring water. Most of the springs are located at higher elevations. The North Horn Formation lacks distinct and persistent lithologic units (Spieker, 1931); therefore, the sandstone of water-bearing lenses of the formation is somewhat discontinuous. This fact, coupled with the fact that recharge zones for the springs are in the nearby flats along the ridges, implies that springs are local in extent as opposed to a larger more regional system.

Seeps and Springs - Springs on Trail Mountain generally issue from sandstone overlying a shale layer. Lines (1985) found that the laboratory hydraulic conductivity of the sandstone and shale units within the Blackhawk Formation varies by four to six orders of magnitude. The relative magnitude of the hydraulic conductivity of local sandstones compared with siltstones and shales indicates that the finer grained sediments of the formations serve as barriers to the downward movement of water.

Recharge into local formations, either through snowmelt, rainfall, or subsurface seepage from an adjacent formation, percolates downward within the sandstone beds; however, upon reaching a less-permeable siltstone or shale layer, the water is forced to flow downdip to the surface, issuing at the interface between the two units.

Four wells have been drilled to monitor groundwater conditions in the Star Point Sandstone. The following table lists the well completion data and the status of each well:

| WELL ID. | DRILL DEPTH (ft) | STRATA MONITORED | POTENTIMETRIC ELEVATION (ft) | MONITORING STATUS |
|---|---|---|---|---|
| TM-1 | 650 | Star Point Sandstone (See Notes Below) | 7259 | Abandoned Relocated to TM-1B (See Notes Below) |
| TM-1B | 480 | Star Point Sandstone (See Notes Below) | 7272 | Quarterly See Monitoring Plan |
| TM-2 | 60 | Spring Canyon Member Star Point Sandstone | 7151 | Abandoned In-Mine Well Area Sealed |

| | | | | |
|---|---|---|---|---|
| TM-3 | 560 | Spring Canyon Member Star Point Sandstone | 6900 | Quarterly See Monitoring Plan |

Well TM-1: Well TM-1 was drilled outside the mine near the main manway portal. The hole was drilled to a total depth of 650 feet, beginning at a point 5.0 feet below the top of the Star Point Sandstone. At this location the Star Point was encountered to a depth of 350 feet, with a transition from the Star Point to the Mancos Shale existing from a depth of 350 feet to 500 feet. Below the 500-foot depth, the Mancos shale is present. The elevation of the ground surface at TM-1 is 7276.0 feet. On September 17, 1993 the static water level in TM-1 was at a depth of 17.4 feet below the surface; hence, the elevation of the potentiometric surface at TM-1 is 7258.6 feet. During routine monitoring on December 20, 1993 the bailer utilized to retrieve the quality samples became lodged in the casing at a depth of approximately forty feet. Several unsuccessful attempts were made to retrieve the bailer. Well TM-1 has been permanently abandoned using Division of Water Rights specifications. Monitoring potential impacts to the Star Point Sandstone at the mine facility was transferred to Well TM-1B on June 22, 1994.

Well TM-1B: Beaver Creek Coal developed a surface well located near the bathhouse (designated as well TM-1B and shown of the Plate 6-2) with the intended purpose of supplying water to the water treatment plant. During well development it was determined that the well production was insufficient to supply the water treatment plant (production was less than five gallons per minute) and the well was temporarily abandoned. Well TM-1B was drilled in October 1987 to a depth of 480 feet, which fully penetrated the Star Point Sandstone formation. Development included setting 480 feet of 6-inch steel casing, perforating the casing from 380-460, and setting a Grundfos 5-10 GPM pump at 420 feet with a 1-inch galvanized discharge line. Monitoring of well TM-1B was initiated in June 1994 with depth on a monthly basis through 2019. Field water quality is collected quarterly and beginning in 2020 depth will also be collected quarterly.

Well TM-2: Well TM-2 was an in-mine well drilled at crosscut 54 in the south mains. The hole was drilled to a total depth of 60 feet, beginning at the top of the Star Point. Only the Spring Canyon Member of the Star Point Sandstone was penetrated in this hole. The elevation of the mine floor and the top of the Star Point Sandstone at TM-2 is 7167.0 feet.

On October 24, 1985 the static water level in TM-2 was at a depth of 16.5 feet below the mine floor. Hence, the elevation of the potentiometric surface at this location is 7150.5 feet.

Well TM-3: PacifiCorp drilled and developed well TM-3 on September 28, 1993 to satisfy a special condition request from the mid-term permit review. Results of an aquifer test conducted April 28, 1994 can be found in Appendix 7-14. Well TM-3 was drilled in Straight Canyon, approximately 11 miles northwest of Orangeville, Utah (SW1/4 NW1/4 of Section 3, Plate 7-2). Well TM-3 was drilled to a total depth of 560 feet. At this location, the Star Point was encountered to a depth of 455 feet, with a transition from the Star Point - Spring Canyon Member to the Mancos Shale existing from a depth of 555 feet to 560 feet. The elevation of the ground surface at TM-3 is 6750 feet. Water in the Star Point Sandstone is under artesian pressure, with the static pressure on June 22, 1994 of 65 psi. Hence, the elevation of the potentiometric surface at TM-3 was 6900.2 feet when the well was completed. Refer to Appendix 7-10 and 7-14 for additional information.

Results of complete chemical analyses from Well TM-1B are presented with other water monitoring data in the Annual Reports (pre-2015). The results of the chemical analyses for samples taken from within the mine are presented in Table 7-1.

Plate 7-1 shows the elevation of the potentiometric surface in the greater Mine area. This data is taken from Lines (1985) and modified using data from Wells TM-1, TM-1B, TM-2 and TM-3. As noted, the potentiometric surface surmised by Lines should be shifted to the south in the vicinity of Cottonwood Creek. Plate 7-1 indicates that the flow of groundwater in the Star Point Sandstone in the vicinity of the Mine is to the south-southwest toward Straight Canyon.

Springs in the vicinity of the Mine are used by cattle, deer, elk and other wildlife. Six of the springs (T-4, T-6, T-8, T-9, T-11, T-15) have been developed with watering troughs or ponds.

Within the Trail Mountain Mine there were only two long-term underground water producing areas. These areas are designated as UG-2 and UG-3 on Plate 7-3. Former monitoring point UG-1 is in an area that was sealed, and monitoring was discontinued in early 1988. Monitoring point UG-2 was sampled-1988 - 2001; over time the flow decreased to less than 0.1 gallons per minute.

During the mining process ground water encountered from fractures, joints and in-mine drillholes has been very minimal and dries up in the span of a few days, which indicates the presence of small pockets of perched water and not an underground aquifer. (Greg Lines, USGS.) Should water underground be encountered that is flowing directly from formation greater than 1 CFS, which continually flows for 30 days, a sample will be collected for lab analysis. The sample will be analyzed for the parameters listed in Appendix 7-1, Groundwater Operational Water Quality Lab Parameters and Field Measurements. The approximate location of the flow will be added to Plate 7-3.

Data presented by Lines (1985) indicate that the total dissolved solids concentrations of water from springs in the North Horn Formation tend to increase in the direction of groundwater flow, i.e., in the south-southwest direction according to Lines, (1985). A review of TDS data collected from springs monitored by PacifiCorp substantiates this observation (review the pre-2015 Annual Hydrologic Monitoring Reports, Springs T-8, T-15 and T-6). The pattern of increasing TDS in a southerly direction could possibly be due to increased leaching of the bedrock in the down gradient direction or contact with altered strata associated with natural burning along the southern outcrop. Insufficient springs were available to determine if such a trend exists within other formations in the vicinity of the mine; however, Lines (1985-Appendix 7-B) found that the pattern did not exist in the Blackhawk-Star Point aquifer.

The pH of water issuing from springs in the survey area showed no trends. Values varied from 7.3 to 8.5, generally falling in the range of 7.3 to 7.6; hence, spring water in the study area is slightly alkaline.

Groundwater Quality - Water quality samples have been collected from seepage within the Mine (per-2015) to determine the groundwater hydrologic conditions within the Blackhawk Formation in which the coal-bearing zone is located. Water quality samples have also been collected from springs to provide an index of groundwater hydrologic conditions within other overlying formations of the mine plan area. The results of the chemical analyses for samples taken from within the mine are presented in Table 7-1.

Mining occurs in the lower Blackhawk Formation, which consists of interbedded layers of sandstone and mudstone separated by mineable and non-minable coal seams. The sandstone beds-fluvial channel systems are generally massive while the mudstone layers are fine textured and tend to swell when wet and decompose into an impervious clay. Because of the aquiclude formed by mudstone layers in the North Horn Formation, recharge to the Blackhawk Formation is limited, even along major fault systems. Due to the lithologic characteristics of the Blackhawk, both vertical and horizontal migration is constricted.

The amount of intercepted groundwater varies when the mine enters virgin country. In most cases the amount of water which flows into the mine exceeds the recharge and, in time, the water inflow decreases in volume (Appendix 7-5). If new areas are not mined, the discharge from the mine will decrease accordingly. Water produced within the mine is used for dust suppression and fire protection within the mine and for the operation of in-mine machinery.

Groundwater chemical quality is very good in strata above the Mancos Shale. The USGS reports a range in dissolved solids from 50 to 750 mg/I for samples from 140 springs in the region issuing from the Starpoint Sandstone and overlying formations (Danielson et al., 1981). Danielson et al. (1981) identified the regional trends of decreasing water quality from north to south and west to east across the Wasatch Plateau. Waters percolation through the underlying Mancos Shale quickly deteriorate, with total dissolved solids concentrations frequently exceeding 3000 mg/1.

The quality also decreases vertically because of the influence of marine sediments along with the trend of decreasing quality from north to south. The predominant dissolved chemical constituents of the groundwater from both surface springs and samples collected in the mine are calcium, bicarbonate, magnesium and sulfate. Concentrations of magnesium are normally about one-half the concentration of calcium. Sulfate concentrations are typically higher in water from springs issuing from the Starpoint-Blackhawk aquifer zone or confined aquifers intersected by mine workings. As mentioned earlier water quality degrades from the north to the south and vertically.

Although the analysis of the overburden samples tested has shown that no toxic or hazardous materials are present, groundwater quality will be protected as described in Section 731.100.

Wells and Uses – Principal groundwater use in the area is wildlife and for stock watering from springs or seeps. Groundwater produced within the mine is used for dust suppression and equipment operation within the mine or discharged under an approved UPDES permit. For additional information refer to Section 722.400.

Mine Dewatering - Generally, water encountered within the mine has been in the form of roof leakers through bolt holes and tension cracks positioned parallel to the working face of the mine. As mining progresses downdip, leakers further than 500 feet updip of the working face generally dry up. Only a limited amount of water is made within the mine. Occasionally mine water production will exceed usage because of inactivity of the mine operation, short-lived surges of inflow, etc. As a result, a system has been constructed to allow for discharge of the mine water from the sump to Cottonwood Creek, with an option of routing the discharge through the sediment pond if necessary. This discharge point is approved under an UPDES Discharge. Pre-2015 the Intercepted groundwater was monitored, quantified and reported annually in the Hydrologic Monitoring Report.

Water Supply - Water required for underground mining operations is supplied from two sources:

1. Underground water from the mine is collected in a sump and recirculated for mining purposes; and
2. Supplemental mine water needs can also be supplied by pumping water from Cottonwood Creek. (Water Rights see Table 7-6, Appendix 7-14L)

Culinary water is supplied from underground sources pumped to a water treatment plant located near the main portal.

Water Rights – There are numerous water rights within the permit and adjacent area. See information provided on Plate 7-4, Appendix 7-6, Appendix 7-14L and in Table 7-6.

## 724.200 Surface Water Information

Cottonwood Canyon Creek - The Cottonwood Canyon Creek is a major drainage system where evidence of glaciation exists. From the headwaters to Section 24, Township 17 South, Range 6 East, the canyon is characterized by U-shaped valleys with associated lateral and terminal moraine deposits. Lateral moraine deposits most commonly occur at the intersection with side canyons. Terminal moraine deposits occur at the northwest corner of Section 24 and from this point to near the confluence with Straight Canyon the canyon can be characterized as a V-shaped valley with little evidence of glaciation.

Based on data collected by PacifiCorp, Cottonwood Canyon Creek is an ephemeral stream from its headwaters to Section 24, Township 17 South, Range 6 East, and intermittent from that point to its confluence with Cottonwood Creek at Straight Canyon. The stream becomes intermittent near the intersection of Roans Canyon just below the terminal moraine deposits discussed above. During drought conditions which have been experienced since 1985, flow in Cottonwood Canyon is limited to flow emanating from the Roans Canyon Spring located in Section 24 near the confluence with Roans Canyon.

Along with Roans Canyon Spring, another spring referred to as Cottonwood Spring (TM-23) is also associated with the alluvial (glacial) deposits. Cottonwood Spring is located in the canyon bottom within the area of terminal moraine deposits at an elevation higher than that of Roans Spring. With normal precipitation, especially in the form of winter snowpack, runoff would saturate the alluvial deposits and a portion of groundwater would discharge at the location of Cottonwood Spring. During the period of the drought recharge to the alluvial deposits has been limited and the level of groundwater has been reduced to a point below the elevation of the Cottonwood Spring. To verify the extent of the alluvial deposits and to define the hydrologic characteristics, PacifiCorp conducted a hydrologic research project in 1992 which included a series of resistivity lines and the drilling of three surface sites (see Deer Creek/Cottonwood/Des-Bee-Dove Permit, Volume 9 - Appendix F for complete details). At each of the surface sites two wells were completed (except for CCCW-2, see Plate 6-2 for well locations); one in the alluvial deposits and one in the Spring Canyon member of the Star Point Sandstone Formation. Wells completed in the alluvial deposits will be utilized to compare the well hydrographs to those of Cottonwood Canyon Creek and

the Star Point Sandstone. Monitoring data was included in the pre-2015 Annual Hydrologic Monitoring Reports.

Surface water-quality data collected from Cottonwood Canyon Creek by PacifiCorp indicate that the dominant ions are: calcium, magnesium, and bicarbonate. Water quality and quantity data collected during the year are presented in the Annual Report pre-2015. Total dissolved solids concentrations in the stream vary from about 250 to 300 milligrams per liter in the mine area, with the lower concentrations normally occurring during the high-flow season. Slight variations have been noted between stations located upstream and downstream from the permit area (SW-1, SW-2 and SW-3).

As expected, total suspended solids concentrations in Cottonwood Canyon Creek tend to vary inversely with the flow rate. Concentrations have varied during the period of record from less than 1 milligram per liter to greater than 1000 milligrams per liter.

Topography in the area is very rugged, with elevation varying from 6800 to over 9000 feet above sea level. Slopes within the mine plan area vary from near vertical cliffs to less than 4 percent (2 degrees) on Trail Mountain. Major escarpments occur to the east and south of the mine plan area.

Because of the remoteness and the limited amount of surface water in and adjacent to the mine plan area, essentially no development of the surface water has occurred except from some possible stock watering. Cottonwood Creek water is used downstream for irrigation and for power generation.

A portion of the Cottonwood Creek watershed receives drainage from within the mine plan area. Stream channels from the mine plan area flow to the east toward the Cottonwood Canyon Creek and to the south toward Straight Canyon Creek, a tributary of Cottonwood Creek.

Cottonwood Creek - The Mine is located immediately adjacent to Cottonwood Canyon Creek a tributary of Cottonwood Creek, one of the major tributaries of the San Rafael River. Near Orangeville, Cottonwood Creek has had an annual flow of 70,700 acre-feet during the

period of record that extends intermittently from 1909 through 1984 (US Geological Survey, 1984). Approximately 50 to 70 percent of stream flow in the mountain streams of the region occurs during May through July (Waddell et al., 1981).

Stream flow during this late spring/early summer period is the result of snowmelt runoff. Snowmelt is the primary source of water for the perennial streams in the San Rafael River Basin with summer precipitation usually producing little runoff (US Geological Survey, 1979). Ephemeral streams are also abundant in the San Rafael River Basin, existing primarily at lower elevations where evapotranspiration significantly exceeds precipitation.

Cottonwood Creek above Straight Canyon drains approximately 21.9 square miles. The average channel gradient of Cottonwood Creek above Straight Canyon is 300 feet/mile (5.7 percent). Only a short period of record (October 1978 to present is available for the USGS stream gaging station (09324200) on Cottonwood Creek above Straight Canyon. Danielson et al. (1981) estimate the average annual precipitation to be on the order of twenty-two (22) inches, or 26,000 acre-feet, on the Cottonwood Creek drainage above Straight Canyon. Danielson et al. (1981) also estimate that only two percent of the precipitation on Cottonwood Creek above Straight Canyon leaves the basin as stream flow compared to thirty percent for Huntington Creek above Huntington. The suggested reasons for the wide difference in percent of precipitation contributing to stream flow are: 1) Cottonwood Creek Basin has a greater portion of area with southern exposure with more gradual slopes than Huntington Creek Basin and 2) possible subsurface movement of water through fractures associated with Joe's Valley Fault. About seventy percent of the total discharge at the Cottonwood Creek station above Straight Canyon for the water year 1979 occurred during the snow melt period (April-July).

Sixty years of data are available for the gaging station on Cottonwood Creek near Orangeville (9324500). The drainage area above Orangeville contributing to Cottonwood Creek is approximately 208 square miles. Cottonwood Creek has an average discharge near Orangeville of about ninety-five (95) cfs, or 69,000 acre-feet per year. The maximum and minimum discharges of record on Cottonwood Creek near Orangeville are 7,220 cfs (August 1, 1964) and 1.2 cfs (April 8, 1966), respectively.

Water use upstream from Castle Valley, the valley containing most of the agricultural land noted in Figure 7-2, is primarily for stockwatering and industrial purposes (coal mining and electrical power generation). Within Castle Valley agriculture and power production utilize nearly all of the inflowing water (Mundorff, 1972), with minimum flows in the gaged streams and rivers in the basin occasionally approaching zero. Storage reservoirs are common at higher elevations throughout the region. Transbasin diversions occur throughout the area.

The quality of water in Cottonwood Creek and other similar streams in the area varies significantly with distance downstream. Waddell et. al. (1981) found that concentrations of dissolved solids varied from 125 to 375 milligrams per liter in major streams in the region in reaches above major diversions to 1600 to 4025 milligrams per liter in reaches below major irrigation diversions and population centers. The major ions at the upper sites were calcium, magnesium, and bicarbonate, whereas sodium and sulfate were more dominant at the lower sites. They attributed the changes to (1) diversion of water containing low dissolved solids concentrations, (2) subsequent irrigation and return drainage from moderate to highly saline soils, (3) groundwater seepage, and (4) inflow of sewage and pollutants from population centers. Average annual sediment yields within the Cottonwood Creek drainage basin range from approximately 0.1 acre-feet per square mile in the headwaters area to about 3.0 acre-feet per square mile near the confluence with the San Rafael River (Waddell et al., 1981).

Water Supply - Surface water in the mine plan and adjacent area is utilized primarily for stock watering purposes. A listing of surface water rights within the permit and adjacent areas is provided in Table 7-6. (Also see Appendix 7-8 Cottonwood Irrigation Shares).

Flow Characteristics - According to Jeppson et al. (1968) the mean annual water yield for the mine plan area is approximately 1.5 inches. Other hydrologic methods (described in Section 721) were used to determine the mean annual water yield to increase the confidence level of the estimate. According to Grunsky's Rule the mean annual water yield from the mine plan area is 2.0 inches. This was determined using an alpha value of 0.008/in. Water yield studies have found values of 0.007 to 0.009 for un-gaged areas with medium elevations, medium summer rainfall, medium temperature, medium soil, moderate slopes and east exposure. Gaged areas such as Black Mesa and Holbrook Creek,

Colorado, and Black Hills, South Dakota, which are similar to the Mine site, have values ranging from 0.0068 to 0.0090.

According to Ol'deKop's formula (Sellars, 1965), the mean annual water yield from the mine plan area is 2.9 inches. The two methods utilize the information that mean annual precipitation and evapotranspiration over the mine plan area are 16 to 19 inches, respectively (Jeppson et al., 1968).; therefore, estimates of the mean annual water yield from both Ol'deKop's and Grunsky's formulas compare favorably with the estimate from the Hydrologic Atlas of Utah prepared by Jeppson et al. (1968).

Monthly flows from Cottonwood Canyon Creek were computed as a percentage of annual flow for the water year 1979 (October 1978 to September 1979) to determine the seasonal distribution of flows for streams within and adjacent to the mine plan area. The results are illustrated in Figure 7-3. Although actual monthly percentages will change, the distribution pattern of stream flow is characteristic of watersheds in the western highlands where the majority of annual water yield occurs in the spring and early summer as a result of snowmelt runoff.

Daily discharge measurements for the Cottonwood Canyon Creek were taken only during the three years 1979, 1980 and 1981. Within those years flow varied from 0 to 22 cfs with an average of 1.64 cfs. The average discharges for the respective three years of record were 0.87, 3.33 and 0.72 cfs. The USGS gauging station monitoring was discontinued in September 1981 (additional information on flow characteristics of Cottonwood Canyon Creek, review annual Hydrologic Reports (pre-2015)).

Surface Water Quality - Three surface water sites (referred to as SW-1, SW-2 and SW-3 on Plate 7-2) have been sampled since 1977 or 1979. Table 7-3 contains a list of the water quality parameters analyzed along with the results of the chemical analyses of surface water samples collected at these three sites. As illustrated in Plate 7-2, SW-1 is located approximately one mile above the mine, SW-2 is located immediately below all mine surface facilities, and SW-3 is located approximately 2 miles below the mine near the confluence of Cottonwood Canyon Creek and Straight Canyon. Additional water quality data have been collected by the USGS at a gaging station on the Cottonwood Canyon Creek located in the

SE1/4NE1/4, Section 36, T17S, R6E. This data is compiled and reported in Table 7-4. This station was discontinued in 1981; however, an additional monitoring station, SW-3, was added by the applicant to monitor Cottonwood Canyon Creek below the permit area. Results from all the monitoring stations are summarized in the Annual Report (pre-2015) and are summarized on Table 7-3 and in the UDOGM water database.

As depicted in Tables 7-3 and 7-4 surface waters of the mine plan area are of a mixed chemical type (Calcium-magnesium, bicarbonate) and seasonally vary from a stronger magnesium-bicarbonate to a stronger calcium-bicarbonate. A sample collected by the USGS in November 1978 was a calcium-bicarbonate type; whereas, those collected in July and September of 1979 were of a stronger magnesium-bicarbonate type.

Total dissolved solids concentrations varied from 226 to 1835 milligrams per liter at stations SW-1, SW-2, USGS gaging station, and SW-3. Measurements were taken during all periods of the year; therefore, this range represents both high and low TDS values to be expected during low and high flow periods of the year. From April to June, when stream discharges are highest due to direct snowmelt, a diluting effect usually occurs in surface waters, resulting in a lower total dissolved solids concentration. Later in the year as flow decreases and the majority of the flow is derived from groundwater, the dilution effect becomes less pronounced and total dissolved solids concentrations increase.

Suspended solids concentrations during the inventory period were found to vary from less than 0.5 milligrams per liter to 5024 milligrams per liter in Cottonwood Canyon Creek. It is known that suspended solids concentrations tend to vary somewhat proportionately with flow rate (Vaughn Hansen Associates, 1979); therefore, during the snowmelt runoff period, suspended solids concentrations are expected to be generally higher than values from low flow periods. The Utah Division Water Quality has classified Cottonwood Creek within the mine plan area as; 1C - protected for domestic purposes with prior treatment by standard complete treatment processes, 3A - protected for cold water species of game fish and other cold-water aquatic life, and 4 - protected for agricultural uses including irrigation of crops and stock watering. Table 7-5 contains the numerical water quality standards applicable to the various classifications. Few samples collected by either Beaver Creek Coal Company or the USGS were noted to exceed the chemical standards. One sample collected at the

USGS gaging station contained a lead concentration of 0.13 milligrams per liter in excess of the standard set in all three applicable state classifications for the waters of Cottonwood Creek.

### 724.300 Geologic Information

Geologic information related to the permit and adjacent areas is presented in Chapter 6 of this M&RP.

Effects of Mining on the Groundwater Hydrologic Balance - As has been noted, the occurrence and quality of water in any region is highly controlled by geology. A structural feature known as the Straight Canyon Syncline may influence the groundwater hydrology in the permit area. The syncline crosses the mine plan in a southeasterly direction. The axis of the syncline, plunging NE-SW at approximately 3.5$^{o}$ is visible on outcrop at the Joes Valley dam. The syncline is a prominent feature and could provide a conduit from groundwater migration from NE-SW. The only data for this area has been obtained from exploration holes which have been drilled near the syncline axis. No unusual or persistent sources of groundwater at the coal seam horizon were noted in holes TMX-2, TMX-6, and TMX-7. As with any syncline structure, increased amounts of intercepted groundwater could be expected as mining approaches the syncline axis. Rather than rapid inundation which can occur along fault zones, a gradual increase in the amount groundwater entering the mine should be anticipated as mining proceeds down dip below the potentiometric surface toward the syncline axis. Since excess water in the mine is stored in sumps, settled and pumped out into Cottonwood Canyon Creek, the net loss to the general hydrologic regime would be minor or zero. The entire permit area is within the Cottonwood drainage system. Inter-basin transfer will not occur from the interception and discharging of groundwater.

Springs - Plate 7-1 shows the location of water sources found during the hydrologic inventory of the mine plan and adjacent area. Based on the data collected by PacifiCorp and the Bureau of Mines on the adjacent East Mountain property, mining induced impacts have not been identified. As discussed in Chapter 5, Section 525.480, subsidence is expected to have no impact on bedrock-aquifer springs in the vicinity of the Mine. Lines (1985) states that mining is not expected to adversely impact water quality in the vicinity of the Trail Mountain Mine (renamed Fossil Rock Mine).

Four runoff fed ponds were also identified during the October 29, 1985 survey. Their locations are shown on Plate 7-1. The ponds numbered 35-1P, 26-1P, 26-2P and 26-3/4P, were sampled for water quality during the 1981 survey and occur within the area of potential subsidence. The subsidence effects on the ponds may result in changes in retention capacity if subsidence fractures intercept them; however, water quality is not likely to be adversely affected.

Control Plans - See Section 732.

### 724.400 Climatological Information

Precipitation - The climate of the permit area has been described by the U.S. Geological Survey, which states that it is semi-arid to sub-humid and precipitation generally increases with altitude. The average annual precipitation ranges from about ten (10) inches in the lowest parts of the permit area (southeast) to more than twenty-five (25) inches in the highest parts (northwest). PacifiCorp's weather station, located in Section 26, Township 17 South, Range 7 East, has provided data which shows that the summer precipitation in the form of thundershowers averages about the same as the winter precipitation in the form of snowfall. Because much of the summer precipitation runs off without infiltration, the winter precipitation has the greatest impact on groundwater.

Precipitation amounts have been recorded at the Hunter and Huntington power plants, at Electric Lake Dam, and on East Mountain (Figure 7-5). Precipitation data can be found pre-2015 in the annual Hydrologic Monitoring Report (See Tables 7-2 and 7-7 for East Mountain data).

Direction and Velocity of Prevailing Winds -The winds in the area are generally variable. The wind rose diagram presented in Figure 7-4 displays the variability for the Meetinghouse Ridge area for January to December 1978.

Seasonal Temperatures Ranges - Air temperatures vary considerably both diurnally and annually throughout the region. Midsummer daytime temperatures in lower areas commonly exceed $100^0$ F, and midwinter nighttime temperatures throughout the area commonly are well below $0^0$ F. The summer temperatures are accompanied by large evaporation rates. Although not recorded, there

probably also is significant sublimation of the winter snowpack, particularly in the higher plateaus which are unprotected from dry winds common to the region. Temperature information is collected at the UP&L weather stations at each power plant, and on East Mountain. Temperatures in the region tend to be inversely related to elevation. These data were included in the annual Hydrologic Monitoring Report (pre-2015), see Table 7-7 for East Mountain data. The Applicant will provide the Division additional data if requested.

### 724.500 Supplemental Information

No supplemental information is required at this time.

### 724.600 Survey of Renewable Resource Lands

The existence and recharge of aquifers in the permit and adjacent areas is discussed in Section 724.100 of this M&RP. A discussion of the potential for material damage or diminution of these aquifers and their recharge areas due to subsidence is provided in Section 728 of this M&RP.

## 724.700 Alluvial Valley Floor Requirements

Utah regulations (R645-302-320) require that the presence of alluvial valley floors in or adjacent to the mine permit area be identified. The existence of an alluvial valley floor is determined to exist **if**:

1) Unconsolidated stream-laid deposits holding streams are present, and

2) There is sufficient water to support agricultural activities as evidenced by:
    a) The existence of flood irrigation in the area in question or its historical use;
    b) The capability of an area to be flood irrigated, based on stream-flow water yield, soils, water quality, topography, and regional practices; or
    c) Sub-irrigation of the lands in question, derived from the groundwater system of the valley floor.

The section examines the potential existence of alluvial valley floors in and adjacent to the areas. First, a general description of the surface operations and site disturbances associated with the Mine. Next, a discussion of geomorphic and characteristics to support irrigation and the water quality and availability of Cottonwood Canyon drainages as a possible alluvial valley floor are presented. Finally, the conclusions of the alluvial valley floor determination are summarized.

Site Description - Surface facilities associated with the Mine plan area consist of the portal area located in Cottonwood Canyon and an access road up Cottonwood Canyon. A description of the mine area is provided in Sections 521,526, 527, coal recovery methods in 522 and mining methods in 523.

Geomorphic Criteria - Alluvial deposits in and adjacent to the mine permit area are shown on Plate 7-5. Plate 7-5 shows the extent of the alluvium as presented by Doelling (1972) and shows that the alluvium is found primarily along Lower Cottonwood Creek and at the mouth of the Cottonwood Canyon Creek just above where it joins Cottonwood Creek. Only very narrow bands of alluvium are found along the Cottonwood Canyon Creek above the canyon mouths.

Water Quality and Availability - Flood irrigation near the mine plan area is currently, and has historically been, confined to the alluvial areas of Lower Cottonwood Creek. Water is

diverted at the mouth of the Cottonwood Canyon Creek where it joins Cottonwood Creek to irrigate fields on the alluvium.

No flood irrigation has historically been practiced on the narrow alluvium land upstream in the canyon opening to lower Cottonwood Creek. A reconnaissance survey of the surrounding region indicates that flood irrigation is also absent in other areas of similar hydrologic, geologic, and biotic characteristics. The historic lack of flood irrigation in these steep, narrow canyons suggests that such activities are not feasible in the region. In addition, the topography is very steep and consequently not conducive to agricultural activities.

Some sub-irrigation of vegetation does occur on the alluvial valley floors shown in Plate 7-5. The sub-irrigated species, mainly cottonwoods and willows, are found along the channels of Cottonwood Creek suggesting that sub-irrigation is confined to the channel areas where the water table is near the surface.

**Alluvial Valley Floor Identification and Potential Impacts**

Based on the foregoing reconnaissance analysis, the canyon of Cottonwood Canyon Creek cannot be considered an alluvial valley floor due to the lack of area for supporting an agriculturally useful crop. The flood or sub-irrigated alluvial areas are located over two miles from the mine permit area and are used for pasture and hay production. Little potential exists for the mine operation to impact the alluvial valley floor. No impacts are anticipated to the alluvial valley floor as shown on Plate 7-5.

## 725 Baseline Cumulative Impact Area Information

The hydrologic and geologic information required for UDOGM to develop a Cumulative Hydrologic Impact Assessment is presented in this M&RP under Chapters 6 and 7. Required information not available in these chapters is available from the Utah Division of Water Rights and Water Resources and from the U.S. Geological Survey, the U.S. Bureau of Land Management, and the U.S. Forest Service.

### 726 Modeling

No numerical groundwater or surface water modeling was conducted in support of this M&RP.

### 727 Alternative Water Source Information

In order to restore land affected by Applicant's mining operations to a condition capable of supporting the current and post-mining land uses stated herein, the Applicant will replace water as discussed in Section 731.100.

The Applicant controls 5 shares in Cottonwood Creek Consolidated Irrigation Company (CCCIC). The Applicant has an agreement with PacifiCorp as part of the Trail Mountain purchase agreement to use the CCCIC shares and acquire additional shares when necessary.

### 728 (PHC) Determination

The Mine operates mine activities to minimize potential impacts to surface and groundwater resources. Suspended material will be allowed to settle in a sediment control structure before discharge into natural drainages. Such discharges will be in accordance with an approved UPDES Discharge Permit.

The protection of the hydrologic resources at the waste rock site is also discussed in the waste rock permit volume.

#### 728.100 Potential Impacts to Surface and Groundwater

Spring and seep surveys and baseline monitoring of groundwater and surface-water resources have been conducted by several entities (private and governmental) over the past several decades in the Fossil Rock Mine (previously the Trail Mountain Mine) and adjacent areas. A PHC determination is provided in Appendix 7-10 (1995 & 2020).

Appendix 7-10 - Excerpts from PHC Determination (2020)

"Information on quantity and quality of surface-water and groundwater under seasonal flow conditions in the Fossil Rock Mine area and adjacent region is presented in Tables 2a and 2b of the PHC (2020). Additional information on groundwater and surface-water quality and quantity in and around the Fossil Rock Mine area has been submitted electronically to the Utah Division of Oil, Gas and Mining through the on-line coal water quality database.

Discharge hydrographs depicting seasonal variability in groundwater quantity and quality for selected springs and seeps in the Fossil Rock Mine area are presented in Attachment A. Discharge hydrographs depicting seasonal variability in surface-water quantity and quality for streams in the are presented in Attachment B. Also included in Attachments A and B are plots of temperature, pH, and specific conductance in addition to a plot of the Palmer Hydrologic Drought Index (PHDI). Water level hydrographs for groundwater monitoring are plotted together with a plot of the PHDI in Attachment C."

Potential coal mining impacts to the hydrologic balance. The potential for the establishment of hydrodynamic communication between the shallow, active-zone groundwater systems that support spring and seep discharges in the Fossil Rock Mine area and the deep, inactive-zone groundwater systems that will likely be encountered in the underground mine workings of the Fossil Rock Mine is considered remote. Accordingly, while the deep inactive-zone groundwaters that exist primarily in sandstone paleochannels immediately overlying the mined coal seam and water which may upwell from the Spring Canyon Member of the Star Point Sandstone, will be dewatered through mining activities, it is considered unlikely that surface waters or shallow groundwaters would migrate from the near surface into the underlying mine.

Active-zone groundwater systems in near-surface sediments and strata in the Price River and North Horn Formations should not be impacted by mining operations.

As was the case during previous mining activity at the Fossil Rock Mine it is anticipated that during future mining, the mine workings in the Fossil Rock Mine will intercept primarily ancient, perched groundwater systems in sandstone channels in the mine roof and possibly also from groundwater upwelling from the mine floor (Mayo and Associates, 1997). Groundwater inflows along intercepted

fault zones may also occur as mining progresses.

Although it is never possible to predict with certainty the nature and magnitude of groundwater inflows that will be intercepted in a coal mining area, it is considered likely that groundwater inflows in the Fossil Rock Mine area will be short lived and of magnitudes similar to those encountered previously in the old Trail Mountain Mine.

As discussed previously, inactive-zone groundwater systems in the Blackhawk Formation occur in isolated partitions that are not in good hydraulic communication with the land surface or shallow overlying active-zone groundwater systems that support springs and seeps. Therefore, it is likely that the groundwater that will be intercepted in the Blackhawk will be groundwater being removed from storage. Because inactive-zone groundwater systems are not in good hydraulic communication with the land surface or shallow, active-zone groundwater systems, groundwater being removed from the Blackhawk Formation is likely not being replenished to any appreciable extent by recharge from adjacent or overlying groundwater systems or from infiltration of surface waters.

At any underground coal mine, subsidence-related interruption and deformation of strata above longwall-mined areas has the potential to alter the pre-mining groundwater flow conditions. The potential for this impact to affect groundwater and surface-water resources in the Fossil Rock Mine is considered low. Subsidence of the land surface overlying coal mining areas is a commonly observed phenomenon in the Utah coal mining environment.

Because planned mining in the Fossil Rock Mine will occur in areas where the overburden exceeds 600 feet, subsidence-related impacts to shallow groundwater systems that support springs and provide baseflow to streams are not anticipated. The presence of a thick zone of unfractured, low-permeability bedrock prevents the downward migration of active-zone groundwaters into the deeper subsurface. Sealing of subsidence cracks by clays in the Blackhawk Formation is expected to minimize long-term effects of subsidence on the hydrologic systems (DOGM, 2013).

Because active-zone groundwater systems will likely not be impacted by subsidence fracturing, the potential for diminution of baseflow in perennial streams is considered remote. Thus, the overall potential for detrimental effects resulting from subsidence fracturing beneath perennial streams is

believed to be low.

The active-zone groundwater systems that support springs and seeps are hydraulically isolated from the inactive-zone groundwater systems that will likely be encountered during mining. For similar reasons (i.e. active-zone groundwater systems that provide baseflow discharge to streams should not be impacted by the proposed mining and reclamation activities), mining-related impacts to surface-water availability will likely not occur. Therefore, it is considered probable that the availability of groundwaters and surface waters will likely not be impacted by the proposed mining and reclamation activities.

Potential for Trans-Basin Diversion. The deep, inactive-zone groundwater systems that are anticipated to be intercepted in the Fossil Rock Mine area are typically not in strong hydraulic communication with shallow active-zone groundwater systems. Consequently, while flow paths of surface-water systems and shallow, active-zone groundwater systems are usually constrained in large measure by surface topography (i.e. drainage basins), the deep, inactive-zone groundwater systems that will likely be intercepted during mining (away from shallow, near-surface outcrop areas) operate independently of the surface topography.

The entirety of the Fossil Rock Mine area is situated within the greater Cottonwood Creek drainage. Each of the three sub-drainages in the area (Cottonwood Canyon, Straight Canyon, and Indian Creek/Lowry Water) are included in the greater Cottonwood Creek surface water drainage (PHC, Figure 8). Accordingly, water that may be intercepted in the underground mine workings at the Mine will be discharged to the Cottonwood Creek drainage, which corresponds to the surface water drainage overlying mining areas. It is anticipated that the removal of deep, inactive-zone groundwaters intercepted in the underground mine environment will not result in any quantifiable diminution of waters from the overlying surface water drainage basin. Rather, the pumping of the ancient, inactive-zone groundwaters intercepted in the mine workings to the receiving surface stream (Cottonwood Canyon Creek) will make water resources available to downstream water users that otherwise would not be available for use.

### 728.200 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of this M&RP. Confidential drill logs

and other information related to geology is in Appendix 6-1. Baseline hydrologic information is presented in Section 724 and Appendix 7-10. The baseline monitoring sources are believed to be representative of existing ground water and surface water.

### 728.300 PHC Determination

The Division will determine if a new or updated PHC determination is required.

### 729 Cumulative Hydrologic Impact Assessment (CHIA)

A Cumulative Hydrologic Impact Assessment to include the permit and adjacent areas is to be prepared by the UDOGM.

## 730 Operation Plan

### 731 General Requirements

This permit application includes an operation plan which addresses the following:

- Groundwater and Surface Water Protection and Monitoring Plan;
- Sediment Pond Sludge Sampling and De-watering Plan;
- Design Criteria and Plans;
- Performance Standards; and
- Reclamation Plan.

### 731.100 Hydrologic-Balance Protection

Groundwater Protection - To protect the hydrologic balance, coal mining and reclamation operations will be conducted to handle earth materials and runoff in a manner that minimizes harmful infiltration to the groundwater system. The Applicant commits to replace loss of surface water and groundwater identified for protection in this M&RP.

Surface Water Protection - To protect the hydrologic balance, coal mining and reclamation operations will be conducted to handle earth materials and runoff to limit contribution of

suspended solids to streamflow outside the permit area. Additionally, the Applicant will maintain adequate runoff and sediment control facilities to protect local surface waters. The Applicant commits to mitigating material damage resulting from subsidence within the leased area as indicated in Section 525.500. The plan for protection of the perennial streams meets the BLM requirements for protection of their water rights (BLM, 1992).

Sediment pond waste is removed from the site and disposed of in the Fossil Rock Waste Rock Site. Previous analyses of this material have shown it to be non-toxic and non-acid forming. Waste sampling will be done as outlined in Section 536 of the Waste Rock Site M&RP.

The restoration of water flows to impacted sources will be accomplished using the Best Technology Currently Available (BTCA). These activities may include, but not necessarily be limited to: piping or trucking water to the location of the loss; sealing surface fractures to prevent further losses, and; construction of a ground water well and the installation of pumps to restore flows. If the above efforts are not successful, then the Applicant will explore the transferring of water rights to the injured party in flow equal to the determined loss and/or monetary reimbursement for proven material damages. The Applicant will meet with the Division to determine if a plan for repair or replacement is necessary. The Applicant reserves the right to appeal the Division's water loss determinations as well as the proposed plan and schedule for water replacement as provided by Utah Code Annotated 40-10-22(3)(a).

### 731.200 Water Monitoring

The monitoring plans for groundwaters and surface-waters are designed to verify that mining-related activities do not adversely impact groundwater or surface-water resources in the mining area and to quantify impact to water quantity and quality in the event that impacts do occur. In addition, the plan is designed to collect data to document that the active-zone springs and streams at the surface in the Fossil Rock Mine area operate independently of the deep, inactive-zone groundwater systems encountered in the underground mine workings.

Baseline monitoring will be conducted on new sites for a two-year period, after which monitoring will revert to the operational lab parameters list. The baseline and operational laboratory parameters are outlined in Appendix 7-1.

Every reasonable attempt will be made to implement and follow the water monitoring plan. However, if monitoring site access is restricted due to snow, inclement weather, etc., the mine's effort to access the area will be documented.

**Ground Water Monitoring**

Groundwater monitoring is proposed to be conducted in the permit and adjacent areas according to the water monitoring plans presented in Appendix 7-1 and which supersedes previous plans. The monitoring plans were developed based on information presented in the PHC determinations, the baseline hydrologic data, and the geology chapter of this M&RP. Plate 7-2 shows the location of the groundwater monitoring sites. The monitoring plan for springs has been designed to include springs that discharge from each of the geologic formations identified.

The existing monitoring well network at Fossil Rock Mine includes CCCW-1A, CCCW-1S, CCCW-2A, CCCW-3A, CCCW-3SU, CCCW-3SL, CWWR1, TM-1B and TM-3.

An inventory of the springs adjacent to the mine plan area was conducted during the spring of 1981 and the fall of 1985(Appendix 7-9). Water quality and quantity data were collected at springs throughout the mine plan and adjacent area. After the quantity and quality data was assembled, representative springs were selected for the groundwater monitoring program.

After 1985, baseline data collected for the area included performing field surveys to identify existing springs. During the field surveys, several springs previously identified could not be found. It is assumed the springs that could not be found have a) stopped flowing; b) were miss mapped; or c) were near springs found during the baseline surveys and were therefore given new number designations.

Groundwater monitoring data are submitted to UDOGM by the end of the quarter following sampling.

Groundwater monitoring will continue through the mining and post-mining periods until bond release.

**Surface Water Monitoring**

Surface water monitoring is conducted in the Mine permit and adjacent areas based upon the monitoring plans and plate contained in Appendix 7-1.

Stream monitoring station along Cottonwood Creek in Cottonwood Canyon include existing location SW-1, SW-2, and SW-3,shown on the monitoring plate in Appendix 7-1.

The parameters monitored meet the requirements of R645-301-731.222.1, 40 CFR 122 and 123, R645-301-751, and the applicable UPDES permits. Surface water monitoring data are submitted to UDOGM for loading into the Divisions database by the end of the quarter following sampling. Surface water monitoring will continue through the mining and post-mining periods until bond release.

### 731.300 Acid- and Toxic-Forming Materials

Results of monitoring of mine discharge, surface, and groundwater, indicate that no impact to these waters from acid- and toxic-forming materials has been found in the permit and adjacent areas (Section 624.200). If acid- or toxic-forming materials are identified, they will be disposed of in the waste rock disposal area. The treatment of these materials will be handled as indicated in Waste Rock volume of this M&RP.

### 731.400 Transfer of Wells

Before final release of bond, exploration or monitoring wells will be sealed in a safe and environmentally sound manner in accordance with R645-301-631, R645-301-738, and R645-301-765. Ownership of wells will be transferred only with prior approval of the UDOGM. The conditions of such a transfer will comply with State and local laws. The Applicant will remain responsible for the management of the well until bond release in accordance with R645-301-529, R645-301- 551, R645-301-631, R645-301-738, and R645-301-765.

### 731.500 Discharges

Discharges into an Underground Mine - The Applicant has no plans to discharge water into an underground mine.

Mine-water discharge consists of water from the underground mine workings diverted into mined-out areas used as underground sumps. These sumps are used to settle out fines before use underground or discharge to the surface. This diversion is done in accordance with the requirements of R645-301-731.100 through R645-301-731.522 and R645-301-731.800.

Gravity Discharges - Mine portals are designed in accordance with R645-301-731.521. This ensures that water will not discharge from the portal by gravity flow. Upon reclamation of the mine, portal seals will be placed in all entries as soon as underground reclamation has been completed. Permanent closure measures will be designed to prevent access to the mine workings by people, livestock, fish and wildlife, machinery and to keep drainage from entering ground or surface waters.

### 731.600 Stream Buffer Zones

The drainage area of Cottonwood Canyon Creek exceeds one square mile. The Division has authorized the installation of a culvert to convey the flow of Cottonwood Canyon Creek beneath the surface facilities of the mine. The culvert will not cause or contribute to the violation of applicable Utah or federal water quality standards and will not adversely affect the water quantity and quality or other environmental resources of the creek.

Stream buffer zone signs are maintained on the west side of Cottonwood Canyon Creek.

The culvert and its appurtenant structures are designed, located, constructed, and maintained to be stable, prevent damage, control the contribution of suspended soilds and to comply with laws and regulations. The culvert will be removed during the final reclamation of the mine site as explained in Chapter 5, Section 542.200.

### 731.700 Cross Section and Maps

The locations of water rights for current users of surface water flowing into, out of, and within the permit and adjacent areas is provided on Plate 7-4. Discharges associated with the permit and adjacent areas are located as presented on Plate 5-2.

The locations of each water diversion, collection, conveyance, treatment, storage, and discharge facility are presented on Plates 5-9 and 5-11. Locations and elevations of each station to be used for water monitoring during coal mining and reclamation operations are presented on Plate 7-2.

The existing topography and cross sections for the primary sedimentation pond are located on Plates 5-2, 5-8 and 5-9. The design topography and cross sections for the waste rock disposal site sedimentation pond are in the Waste Rock volume of this M&RP.

Other relevant cross sections or maps are presented and discussed in Chapter 5 of this M&RP.

### 731.800 Water Rights and Replacement

Refer to Chapter 5, Section 525.480.

### 732 Sediment Control Measures

The sedimentation pond is sized to contain runoff from the area of the mine facilities. As shown in Plate 5-8, there are no diversion ditches for undisturbed area runoff. A description of the Mine's sediment controls in provided in Section 732, 733 and 734.

Runoff from the side canyon above the operation will be bypassed through a culvert connected into the Mine site Cottonwood Creek large bypass culvert. Drainage areas for the side canyon culvert and Cottonwood Canyon culvert are shown on Plate 7-6. Drainage areas for the disturbed and undisturbed drainage to the sediment pond are shown on Plate 7-5.

A diversion culvert and curb and gutter system conveys runoff from the disturbed area to the sedimentation pond. The diversion culverts for Cottonwood Creek were designed and sized by the U.S. Forest Service and the Division of Oil, Gas and Mining to pass runoff from the 50 year, 24-hour storm (from Miller et al. (1973), Figure 39, page 41]. See Appendix 7-3 for

Culvert Specifications, Appendix 7-13 for Culvert Extension Details and Plate 5-15 for Cross Sections.

Peak flows and peak flow design related information for the diversion ditch and culverts are contained in Table 5-7. Design criteria and calculation results for sizes and flows in the diversion system at maximum discharge are presented in Table 5-12.

The design flood includes all of the Cottonwood Canyon runoff, down to and including the side drainage and the three culvert inlets from the opposite side of the highway, as shown on Plate 5-9.

Other minor inlets to the sediment pond include a small road and pad area at the top of the switchback above the pond. A culvert which picks up a small amount of road drainage below the gate was installed in 1988 to catch runoff below the gate which may contain dust or mud carried onto the highway by the haul trucks. A third minor inlet was the mine water discharge line located in the 2nd portal south of ROM belt portal. The disconnected discharge line was optionally used to channel mine water discharge through the sediment pond in lieu of discharging directly to Cottonwood Creek. A replacement line discharges mine water to a storage tank. From the storage tank, water can be discharged to an existing 48" culvert as shown on Plate 5-9. All inlets are shown on Plate 5-9. Design criteria and sizing are shown in Table 5-12.

Sedimentation Pond Design - The sedimentation pond was designed to contain sediment storage volume from 0.05 acre-feet of sediment per acre to disturbed area.
Spillway capacity requirements for the sedimentation pond were based on runoff from the 25-year, 24-hour storm (2.9 inches). Table 5-9 contains the volume and spillway capacity requirements for the pond as well as additional design related information.

The pond design details for the sedimentation pond are illustrated on Plate 5-8. The sedimentation pond consists of a sediment storage pool, a dead pool, and a runoff control pool equal to the inflow volume from a 10-year, 24-hour storm (2.4 inches). A dewatering device is placed in the pond to draw the pond level down to the bottom of the runoff control pool in anticipation of a future runoff event. The Utah Division of Environmental Quality

requires that no dewatering device be placed within three feet of the top of the sediment cleanout level (60 percent); therefore, a dead storage pool has been created to meet the requirements of both agencies. The proposed principal and emergency spillway system consists of a corrugated metal riser and conduit with an anti-vortex device, trash rack, and anti-seep collars. Utilizing Equation 5-1, which defines orifice flow, the discharge capacity of the riser-conduit combination with a diameter of 48 inches was found adequate in passing the peak inflow resulting from the 25-year, 24-hour storm.

Orifice flow occurs when the flow is restricted by the opening and can be determined as;

$$q = CA\ (2gH)^{?} \qquad (5\text{-}1)$$

where q is as previously defined; C is a coefficient dependent upon the orifice geometry (0.6 in this case); A is the cross-sectional area of the opening, in square feet; g is the gravitational constant (32.2 feet per second squared); and H is the head above the orifice inlet, in feet. The orifices considered are the riser inlet and the inlet of the conduit leading from the riser through the pond embankment.

The total embankment height was obtained by adding the stage at full storage capacity, the head of water over the spillway under design flow conditions, the required freeboard height (1.0 feet), and a five percent settlement allowance. The embankment top width will not be less than (H + 35)/5 where H is the height of the embankment, in feet. Table 5-10 summarizes the design specifications for the sedimentation pond.

The sedimentation pond is constructed between the excavated slope of the old pond and a new embankment constructed over the 66-inch culvert. The excavated slope of the old pond was approximately equal to 1.06H:1V. To obtain the necessary pond storage capacity, the remaining inside slopes of the pond was designed at 2h:1V. The pond is lined with 18 inches of a 10:1 mixture of the embankment material and bentonite, respectively, to prevent seepage and piping.

The dewatering device consists of a 12-inch corrugated metal riser and an 8-inch conduit drain line, antivortex device, trash rack, and anti-seep collars. The anti-vortex also acts as a skimming device by not allowing water to be pulled directly from the surface of the pond. A water control gate valve is located at the end of the 8-inch diameter corrugated metal

conduit within the 48-inch spillway within the pond embankment to allow efficient water release.

This was necessitated by the facts that:

1) The water control gate valve must be installed in the manhole/spillway to allow access to the valve;

2) The location of the riser does not allow access to the gate if placed at the extreme inlet;

3) Gates were apparently not available which could be attached between two culverts in a watertight manner; and

4) It was desirable to allow access to the control gate for maintenance purposes.

The control gate operator mechanism is located above the spillway cover. Access to the gate for maintenance can be made via a ladder or rebar rungs which have been welded to the spillway side. A walkway has been installed to allow access to the control gate for purposes of dewatering and inspection. Anti-seep collars have been used based on methods outlined by the U.S. Environmental Protection Agency (1976). Plate 5-8 shows the location and size of the anti-seep collars.

Riprap was placed in the inlet channels and below the outlet conduit of the pond to dissipate energy and reduce erosion potential. Riprap was placed on the inside slope of the pond embankment to a width of five feet on both sides of the spillway and dewatering device up the full height of the embankment to protect the embankment from erosion. The outlet culvert from the pond discharges onto the riprap protection on the main channel as described in Appendix 7-3.

The sedimentation pond will be inspected quarterly, and a copy of the inspection report will be kept at the mine site and an engineer certified copy sent to the Division.

Sediment Disposal Plans - Sediment will be cleaned out at approximately 60 percent of the sediment storage level. The point at which cleanout becomes necessary is approximately 11.2 feet below the top of the riser. Sediment removed from the pond will be temporarily stored within the drainage basin to the pond and eventually disposed of at the Waste Rock

Facility.

Pond Reclamation - The disturbed area of the pond has been seeded with the interim (contemporaneous) seed mix. Permanent reclamation of the pond is discussed under Sections 540 and 763.

The design of the Waste Rock pond is located in a separate volume of this M&RP.

The existing sediment control measures within the permit area have been designed, constructed, and maintained to prevent additional contributions of sediment to streamflow or to runoff outside the permit area. In addition, they have been designed to meet applicable effluent limitations, and minimize erosion to the extent possible. The structures to be used for the runoff-control plan for the permit area include disturbed and undisturbed area diversion channels, sedimentation ponds, containment berms, silt fences, and road diversions and culverts.

The side canyon culvert was designed to pass runoff from the 10-year, 24-hour storm (2.4 inches). Miller et al. (1973) gives values for precipitation, their Figure 27 indicates a 10-year, 24-hour storm precipitation at the mine site of 2.4 inches.

A diversion culvert and curb and gutter system conveys runoff from the disturbed area to the sedimentation pond. The culvert and gutter system were designed to pass runoff from the 10-year, 24-hour storm (2.4 inches).

Diversion with riprap has a higher roughness coefficient. Peak flows and peak flow design related information for the diversion ditch and culverts are contained in Table 5-7.

The soil conservation service equation for calculation of watershed lag times ($t_L$) was used in this analysis:

$$t_L = \frac{\left(l^{0.8}\right)\left(S+1\right)^{0.7}}{1900Y^{0.5}} \quad \text{and} \quad S = \frac{1000}{CN} - 10$$

Where $l$ = the hydraulic length (ft)

Y = the average water shed slope (%)

S = the storage at saturation

CN = curve number

The drainage basin characteristics are given in Table 5-7 along with the resultant:

$T_L$ values: canyon = $(6375)^{0.8}$ $(2.5 + 1)^{0.7}/1900$ $(49.12)^{0.5}$ = 0.2.

Drainage areas for the side canyon 48-inch culvert and Cottonwood Canyon 66-inch culvert are shown on Plate 7-6. Drainage areas for the disturbed and undisturbed drainage to the sediment pond are shown on Plate 7-5. The diversion culverts for Cottonwood Creek were designed and sized by the U.S. Forest Service and the Division of Oil, Gas and Mining to pass runoff from the 50 year, 24-hour storm [3.2 inches - from Miller et al. (1973), Figure 39, page 41]. The culvert was extended 300 feet upstream in the fall of 1990. See Appendix 7-3 for Culvert Specifications, Appendix 7-13 for Culvert Extension Details and Plate 5-15 for Cross Sections. The culvert was subsequently verified by Vaughn Hansen and Associates as shown in Appendix 7-3. The culvert was originally designed with a capacity of 535 cfs, based on the USFS design flood of 450 cfs and the Vaughn Hansen and Associates design flood of 510 cfs. The culvert was extended in 1990, and the design was verified for the 510 cfs flow as shown in Appendix 7-13. The design flood includes the Cottonwood Canyon runoff, down to and including the side drainage and the three culvert inlets from the opposite side of the highway, as shown on Plate 5-9.

Design criteria and calculation results for sizes and flows in the diversion system at maximum discharge are presented in Table 5-12. Also contained in Table 5-12 is the required mean rock diameter ($D_{50}$) for cross sections (with velocities in excess of five feet per second) which would require a rock riprap lining; however, the maximum flow does not result in velocities significantly larger than 5 fps on the non-metal surfaces.

Sediment Pond Inlets – Refer to Section 532, the inlets are shown on Plate 5-9. Design criteria and sizing are shown in Table 5-12.

Sedimentation Pond Design – Refer to Section 532 for pond design details. The design details are illustrated on Plate 5-8.

Spillway capacity requirements for the sedimentation pond were based on runoff from the

25-year, 24-hour storm (2.9 inches). Table 5-9 contains the volume and spillway capacity requirements for the pond as well as additional design related information. Plate 5-8 shows the location and size of the anti-seep collars.

Riprap was placed in the inlet channels and below the outlet conduit of the pond to dissipate energy and reduce erosion potential. Riprap was placed on the inside slope of the pond embankment to a width of five feet on both sides of the spillway and dewatering device up the full height of the embankment to protect the embankment from erosion. The outlet culvert from the pond discharges onto the riprap protection on the main channel as described in Appendix 7-3.

"BTCA" Areas - It should be noted that two small areas of disturbance do not drain to the pond. The first "BTCA" area consists of approximately 0.21 acres located just south of the sediment pond. The calculated runoff from this area is 0.013 acre feet, based on the 0.21 acres and a 10-year, 24-hour event. The area is vegetated, and drainage is sufficiently treated by the vegetation. The realigned stream channel is protected with large (approved size) riprap.

The second area consists of approximately 0.04 acres located on the outslope of the parking lot and drains to the Cottonwood Canyon Creek. The BTCA is riprapped with rock to control erosion and sufficiently treated by the vegetation. See Plate 5-11 for Typical Sediment Control Measures. Runoff from the area for a 10-year, 24-hour event is calculated to 0.004 acre feet.

The "BTCA" areas are shown on Plates 3-1 and 7-5. It should be noted that these areas are included in the total disturbed area for the site (10.39 acres) but are not included in the runoff calculations for disturbed area draining to the pond (Note: 0.16 acres of disturbed area on the new ventilation portal access road drain into the mine, not to the pond). Refer to Section 732 for additional information on BTCA areas

### 732.100 Siltation Structures

The siltation structures within the permit area consist of the sedimentation pond(s) described in

Section 732.200

### 732.200 Sedimentation Ponds

There is one sedimentation pond operating at the mine facility. A second pond is located at the waste rock disposal site.

The sedimentation pond is located at the lower end of the existing mine facilities. The sedimentation pond topography and cross sections are presented on Plates 5-2, 5-8 and 5-9.

The sedimentation pond located at the waste rock disposal site is presented on Plates 4-13 and 4-14 of Waste Rock volume of this M&RP. A discussion of the operation, maintenance, and reclamation of this pond is also contained therein.

MSHA Requirements - MSHA requirements defined in 30CFR 77.216 are not applicable since the existing sediment ponds do not impound water or sediment to an elevation of 20 feet or more above the upstream toe of the structure. The ponds also store a volume less the 20 acre-feet.

### 732.300 Diversions

The objective of the run-off control plan is to isolate, to the maximum degree possible, run-off from disturbed areas from that of undisturbed areas. This is accomplished by:

- Allowing all upstream runoff to by-pass the disturbed area via a network of culverts.
- Routing of any run-off from undisturbed areas which enters the disturbed area into the sediment control system.

Refer to Chapter 5 Section 532 for a discussion of the diversions at the mine.

### 732.400 Road Drainage

Road drainage facilities include diversion ditches, culverts, containment berms, and/or water bars. The road drainage diversion ditches and culverts for the mine site are presented in Chapter 5, Section 532.

The operation of the road drainage diversions within the waste rock disposal site is presented in Waste Rock volume of this M&RP.

## 733 Impoundments

### 733.100 General Plans

A general plan for the sediment pond at the mine site in presented in Chapter 5, details in Section 532.

Maps and Cross Sections - Maps and cross section of the pond are shown on Plates 5-2, 5-8 and 5-9. Maps and cross sections of the sedimentation ponds have been prepared by or under the direction of and certified by a qualified, registered, professional engineer.

The design topography and cross sections for the waste rock disposal site sedimentation pond are in Waste Rock volume of this M&RP.

Subsidence Survey Results - No underground coal mining occurs beneath the existing impoundments within the permit area and, therefore, there has been no effect from subsidence.

Hydrologic Impact - The preliminary hydrologic and geologic information required to assess the hydrologic impacts of the impoundments can be found in Section 724 and Chapter 6, respectively
.

### 733.200 Permanent and Temporary Impoundments

Impoundments have been designed and constructed using current, prudent, engineering practices. Specific foundation design and construction criteria are presented in Chapter 5 of this M&RP.

Permanent Impoundments - There are no permanent impoundment structures within the permit boundary. The construction of the temporary impoundments at the mine are part of coal mining and reclamation operations.

Hazard Notifications - The sedimentation ponds will be examined for structural weakness and erosion at least four times per year. A report of these findings will be submitted to the UDOGM.

### 734 Discharge Structures

Discharge structures for the sediment ponds are shown on Plates 5-8 and 5-9. The structures will be constructed and maintained to comply with R645-301-744.

### 735 Excess Spoil

There is no excess spoil generated at the mine.

### 736 Coal Mine Waste

Areas designated for the disposal of coal mine waste and coal mine waste structures are constructed and maintained as described in Waste Rock volume of this M&RP.

### 737 Noncoal Mine Waste

Noncoal mine waste is stored and disposed of as described in Chapter 5, Section 528.

### 738 Temporary Casing and Sealing of Wells

Each groundwater monitoring well identified will be operated and maintained as described in Section 748.

## 740 Design Criteria and Plans

### 741 General Requirements

This M&RP includes site-specific plans that incorporate minimum design criteria for the control of drainage from disturbed and undisturbed areas.

### 742 Sediment Control Measures

#### 742.100 General Requirements

Design - Existing sediment control measures have been designed, constructed and maintained to provide the following:

- Prevent additional contributions of sediment to stream flow or to runoff outside the permit area.
- Meet the effluent limitations defined in Section 751.
- Minimize erosion to the extent possible.

Measures and Methods - The sediment control measures at the mine include practices carried out within and adjacent to the disturbed area. Sediment control methods include:

- Retention of sediment within the disturbed area;
- Diversion of runoff away from the disturbed area;
- Diversion of runoff using channels or culverts through disturbed areas to prevent additional erosion;
- Cut and fill slopes within the disturbed area will be revegetated with a quick growing vegetative cover. See Chapter 3, Section 352.
- Provide straw dikes, riprap, silt fences, check dams, mulches, vegetative sediment filters, ponds and other measures that reduce overland flow velocities, reduce runoff volumes or trap sediment;
- Treatment of mine drainage in underground sumps.

### 742.200 Siltation Structures

Additional contributions of suspended solids and sediment to stream flow or runoff outside the permit area are being prevented to the extent possible using various siltation structures. Typical sediment control measures are shown in Plate 5-11.

**Sedimentation Ponds**

Sediment control at the mine site is comprised of a single pond. It is located adjacent and down gradient of the disturbed area. The pond has:

- adequate sediment storage,
- detention time is adequate to allow the effluent from the ponds to meet Utah and federal effluent limitations,
- designed to contain the 10-year 24-hour precipitation event,
- A non-clogging dewatering device designed for the pond.

Short Circuiting - Short circuiting is minimized in the mine sedimentation pond and the waste rock disposal site sedimentation pond because both ponds will fully contain the runoff from the 10-year, 24-hour precipitation event.

Sediment Removal - Sediment removal from the sedimentation ponds will be conducted when the sediment level reaches the approximate 60% clean-out level. Existing sedimentation ponds within the permit area have been operating for a period long enough to ensure that any settlement which may have occurred is now complete.

Embankment Material - During construction of the sedimentation pond and the waste rock disposal site sedimentation pond the embankment materials were free of sod, large roots, frozen soil, and acid- or toxic forming coal-processing waste.

Compaction - The Applicant does not have records of the compaction of the embankment of the ponds. However, the ponds have been in place for many years without any reported issues that would relate to the lack of compaction of the pond embankment.

Spillways - The single open channel spillways are of non-erodible construction and are designed to carry sustained flows.

### 742.300 Diversions

The diversions within the permit area consist of drainage ditches and culverts, designed to minimize adverse impacts to the hydrologic balance, to prevent material damage outside the permit area and to assure the safety of the public. Diversions and diversion structures have been designed, located, constructed, maintained and used to: be stable, provide protection against flooding, and prevent additional contributions of suspended solids to stream flow outside the permit area.

The storm runoff calculations for the temporary diversion structures were based on the 10-year, 24-hour precipitation event of 2.4 inches. Refer to Appendix 7-3, Hydrologic Conveyance Facilities and Appendix 7-13 - Culvert Extension for addition information. Diversions within the permit area will be reclaimed in accordance with the reclamation plan defined in Chapter 5.

Diversion of Miscellaneous Flows - Diversion ditches and culverts have been utilized within the permit area to divert miscellaneous flows from disturbed and undisturbed area drainages. A summary table of the minimum channel geometry, channel slope, peak discharge, minimum riprap requirements, maximum flow velocity and minimum freeboard values for each diversion ditch within the facilities area are presented in Appendix 7-3. A list of culverts and size requirements are also show in Appendix 7-3.

### 742.400 Road Drainage

The existing roads within the mine area and waste rock disposal site are discussed in Chapter 5, Section 527.100. The roads have been constructed to include adequate drainage and none of the roads are located in the channel of an intermittent or perennial stream. Roads have been located to minimize downstream sedimentation and flooding.

## 743 Impoundments

The pond(s) on site do not meet the MSHA size criteria in 30CFR 77.216(a). The impoundments are designed with a minimum 2 feet of freeboard. The pond designs were prepared by, or under the direction of, and certified by: a qualified, registered, professional engineer. The Pond(s) have single-open channel spillway that are of non-erodible construction and designed to carry sustained flows. Impoundments will be inspected as described under R645-301-514.300.

## 744 Discharge Structures

The discharge structures within the permit area consist of the primary and emergency spillways on sedimentation pond(s). Discharge from the sedimentation pond(s) will be controlled by riprap channels to reduce erosion. Discharge structures within the permit area were designed and constructed according to standard engineering design procedures.

## 745 Disposal of Excess Spoil

There is no excess spoil within the permit area.

## 746 Coal Mine Waste

### 746.100 General Requirements

Coal mine waste will be placed in a controlled manner to minimize adverse effects of leachate and surface water runoff and groundwater quality and quantity. A description of the methods of placement can be found in Waste Rock volume of this M&RP.

### 746.200 Refuse Piles

A detailed description of the refuse piles at the waste rock disposal site can be found in the Volume assigned to the waste rock site of this M&RP. Surface precipitation falling on the fill is channeled to the sedimentation pond located down gradient of the disposal area fill. Surface drainage from the areas above the site is commingled with runoff from the surface of the refuse pile and sent to the pond.

### 746.300 Impounding Structures

There are no impounding structures within the permit area that are constructed of coal mine waste or are used to impound coal mine waste.

### 746.400 Return of Coal Processing Waste to Underground

Coal processing waste is not returned to abandon underground workings at this facility.

## 747 Disposal of Noncoal Mine Waste

Disposal of noncoal mine waste is discussed in Chapter 5, Section 528 .

## 748 Casing and Sealing of Wells

Water wells have been cased, sealed, or otherwise managed, as approved by the UDOGM to prevent acid or other toxic drainage from entering ground or surface water, to minimize disturbance to the hydrologic balance, and to ensure the safety of people, livestock, fish and wildlife, and machinery in the permit and adjacent area.

If a well is exposed by coal mining or reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the UDOGM.

## 750 Performance Standards

Mining and reclamation operations will be conducted to minimize disturbance to the hydrologic balance within the permit and adjacent areas, to prevent material damage to the hydrologic balance outside the permit area and support approved postmining land uses.

### 751 Water Quality Standards and Effluent Limitations

Discharges of water from disturbed areas will be in compliance with Utah and federal water quality laws and regulations and with effluent limitations for coal mining.

### 752 Sediment Control Measures

Sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 760.

#### 752.100 Siltation Structures and Diversions

Siltation structures and diversions will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 732, 742, and 763.

A perpetual discharge from the sealed Cottonwood Mine portals is located on the east side of the mine site. This discharge flows under the Emery County road via a culvert and connects to the bypass culvert. At reclamation, the Applicant will install an outfall splash apron with scour cutoff Key to accept the discharge from the culvert into the creek (See Plate 5-10). A diagram of the splash apron is in Appendix 7-18. Due to the lack of information regarding the exact location and orientation of the culvert, it is assumed that the culvert projects exactly perpendicular to the road and is exactly level with the effluent entry point, the design accounts for these assumptions. The Applicant accepts no responsibility for the quality of the discharge water at this location. It is assumed that the UPDES permit holder of this discharge point takes all responsibility for the quality of the discharge according to their permit.

### 752.200 Road Drainage

Roads will be located, designed, constructed, reconstructed, used, maintained and reclaimed according to plans and designs presented in Sections 732.400, 742.400, and 762. Roads have been designed to:

- Control or prevent erosion, siltation and the air pollution attendant to erosion by vegetating or otherwise stabilizing all exposed surfaces in accordance with current, prudent engineering practices;
- Control or prevent additional contributions of suspended solids to stream flow or runoff outside the permit area;
- Neither cause nor contribute to, directly or indirectly, the violation of effluent standards given under Section 751
- Minimize the diminution to or degradation of the quality or quantity of surface and ground-water systems;
- Refrain from significantly altering the normal flow of water in stream beds or drainage channels.

### 753 Impoundments and Discharge Structures

Impoundments and discharge structures will be located, maintained, constructed and reclaimed as described in Sections 733, 734, 743, 745, and 760.

### 754 Disposal of Excess Spoil, Coal Mine Waste and Noncoal Mine Waste

Disposal areas for coal mine waste and noncoal mine waste will be located, maintained, constructed and reclaimed as described in Sections 736, 737, 746, 747, 760 and Chapter 5.

### 755 Casing and Sealing of Wells

Wells will be managed as described in Sections 748 and 765. Water monitoring wells will be managed on a temporary basis as described in Section 738.

## 760 Reclamation

### 761 General Requirements

A detailed reclamation plan for the mine is presented in Section 540.

### 762 Roads

Roads not to be retained for use under an approved postmining land use will be reclaimed immediately after it is no longer needed for coal mining and reclamation operations.

#### 762.100 Restoring the Natural Drainage Patterns

Natural drainage patterns will be restored.

#### 762.200 Reshaping Cut and Fill Slopes

Cut and fill slopes will be reshaped to be compatible with the postmining land use and to complement the drainage pattern of the surrounding terrain.

### 763 Siltation Structures

#### 763.100 Maintenance of Siltation Structures

Siltation structures will be maintained until removed in accordance with the approved reclamation plan.

#### 763.200 Removal of Siltation Structures

When a siltation structure is removed, the land on which the siltation structure was located will be regraded and revegetated in accordance with the reclamation plan presented in Section 540.

### 764 Structure Removal

A timetable for the removal of structures is presented in Table 3-3.

### 765 Permanent Casing and Sealing of Wells

When no longer needed for monitoring or other use approved by the UDOGM or unless approved for transfer as a water well, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by UDOGM. Permanent closure measures will be designed to prevent access to the mine workings and to keep acid or other toxic drainage from entering ground or surface waters.

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## Table 7-1
## Results of Groundwater Quality Analyses

| | Belt Entry 24+00 1-Jun-79 | Belt Entry 24+00 Jul-79 | Station #134 6-Sep-79 | Intake #4 29 & 35 Oct-79 | Entry #4 31+00 1-Nov-79 | Station #114 1st Right 27-Nov-79 | Station #138 1st Left 32+40 27-Dec-79 | Entry #1 South Section 31-Jan-80 | Entry #2 32+00 25-Feb-80 | Entry #2 1st Right 5+00 27-Mar-80 | Entry #4 West Section 8+50 Jun-80 | Belt Entry 24+00 Jul-80 | Entry #2 West Section 11+70 Aug-80 | Entry #3 West Section Sep-80 | Entry #3 West Section 17+50 3-Oct-80 | South Section 34+75 24-Nov-80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conductivity, mmhos/cm** | 780 | 330 | 320 | 1000 | 630 | 1850 | 700 | 480 | 430 | 490 | 470 | 780 | 520 | 785 | 1200 | 490 |
| **pH, Units** | 7.62 | 7.22 | 7.6 | 7.6 | 7.75 | 6.2 | 3.2* | 7.85 | 8 | 8.6 | 7.8 | 7.62 | 7.8 | 8 | 2.6* | 7.6 |
| **Iron (Disolved), mg/L** | 0.25 | 0.17 | 0.02 | 0.025 | 0.1 | 0.125 | 0.13 | 0.122 | 0.06 | 0.035 | 0.059 | 0.25 | 0.22 | 0.017 | 0.096 | 0.12 |
| **Iron (Total), mg/L** | 0.31 | 0.17 | 0.11 | 0.115 | 0.136 | 0.33 | 0.385 | 0.15 | 0.11 | 0.157 | 0.13 | 0.31 | 0.26 | 0.16 | 0.169 | 0.15 |
| **Manganese, mg/L** | 0.009 | 0.009 | 0 | | | | | | | | | | | | | |
| **Oil & Grease, mg/L** | 0.009 | 0.009 | 0.009 | 0.01 | 0.01 | 0.01 | 0.012 | 0.015 | 0.01 | 0.014 | 0.013 | 0.009 | 0.01 | 0.01 | 0.005 | 0.005 |
| **Sulfate, mg/L** | 52 | 710 | <1.0 | 320 | 410 | 540 | 370 | 26 | 21 | <1.0 | <1.0 | 52 | 6 | 4.5 | <0.1 | <1.0 |
| **Suspended Solids, mg/L** | 320 | 3 | 2 | 1 | 1 | <0.1 | 1.5 | 1.5 | 3.5 | 5 | 5 | 320 | 5 | 9 | 8 | 7 |
| **Total Dissolved Solids, mg/L** | 500 | 2700 | 420 | 857 | 406 | 1200 | 560 | 336 | 280 | 320 | 310 | 500 | 364 | 550 | 840 | 320 |

On one location in the mine was known to product a sufficient groundwater flow (approximately one gal. per day) to suggest sampling. These locations was identified as UG-1 on Figure 6-9. Over 30 samples from this site have been analyzed during the 1979 - 1983 period. The lowest pH was 6.8 and most are above 7.5. Alkalinities are also high, generally above 240 mg/L as CaCO3 which indicates a large pH burrering capacity. (See Annual Reports for Water Monitoring Data). Other samples from misc. sites in the mine show similar results. *The low pH samples in Table 7-1 are either erroneous or else samples of small stagnant pools, not representative of any significant water generated with the mine.

Note: UG-1 was rendered inaccessible in 1988. A new underground monitoring site, UG-2, has since been selected for monitoring.

02/15/1990

# Table 7-2

**ENERGY WEST MINING COMPANY**
**EAST MOUNTAIN PRECIPITATION**
**HISTORICAL COMPARISON**

| NTH | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 MIN | | MEAN | MAX | ST DEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| r | 1.28 | 1.93 | 0.38 | 0.76 | 3.27 | 1.15 | 1.57 | 2.77 | 0.61 | 0.28 | 0.48 | 0.49 | 1.57 | 2.23 | 1.86 | 0.18 | 1.50 | 0.24 | 3.01 | 0.04 | 3.48 | 0.11 | 0.04 | 1.33 | 3.48 | 1.06 |
| / | 0.39 | 0.53 | 2.90 | 2.43 | 0.97 | 2.38 | 0.39 | 1.91 | 0.43 | 0.39 | 0.26 | 1.07 | 0.57 | 1.12 | 1.42 | 0.46 | 1.63 | 0.84 | 1.08 | 0.05 | 0.62 | 0.40 | 0.05 | 1.01 | 2.90 | 0.77 |
| : | 0.05 | 0.97 | 1.39 | 2.42 | 1.67 | 0.87 | 0.16 | 1.29 | 1.56 | 0.16 | 0.66 | 0.07 | 1.53 | 0.14 | 0.65 | 0.64 | 1.66 | 0.23 | 0.00 | 0.28 | 0.39 | 0.18 | 0.00 | 0.77 | 2.42 | 0.68 |
| I | 0.29 | 3.22 | 1.30 | 0.27 | 0.49 | 0.30 | 1.37 | 1.42 | 1.00 | 0.74 | 0.34 | 0.61 | 4.10 | 0.32 | 1.37 | 1.39 | 2.49 | 0.97 | 0.75 | 0.48 | 1.96 | 0.03 | 0.03 | 1.15 | 4.10 | 1.00 |
| I | 0.52 | 0.14 | 1.81 | 0.65 | 0.59 | 2.10 | 1.37 | 0.00 | 0.68 | 2.08 | 0.39 | 1.73 | 2.34 | 1.35 | 0.66 | 1.18 | 1.56 | 3.34 | 0.34 | 3.27 | 1.21 | 0.19 | 0.00 | 1.25 | 3.34 | 0.93 |
| R | 2.77 | 1.67 | 1.98 | 1.22 | 1.77 | 1.43 | 1.65 | 0.99 | 1.03 | 1.75 | 2.34 | 2.39 | 2.01 | 0.34 | 0.79 | 2.23 | 0.00 | 0.71 | 0.07 | 1.56 | 1.03 | 0.10 | 0.00 | 1.36 | 2.77 | 0.78 |
| R | 0.64 | 0.00 | 0.92 | 0.50 | 1.35 | 1.05 | 1.16 | 2.08 | 0.26 | 1.03 | 0.59 | 0.56 | 0.33 | 2.65 | 3.75 | 0.21 | 0.40 | 0.81 | 2.82 | 0.15 | 1.12 | 0.16 | 0.00 | 1.02 | 3.75 | 0.96 |
| r | 0.87 | 0.45 | 0.71 | 0.22 | 1.73 | 0.38 | 1.77 | 1.03 | 0.47 | 0.26 | 1.83 | 2.19 | 0.72 | 0.36 | 2.29 | 1.14 | 0.91 | 0.37 | 0.36 | 0.72 | 1.39 | 0.00 | 0.00 | 0.92 | 2.29 | 0.66 |
| I | 0.11 | 0.09 | 0.61 | 1.18 | 0.28 | 0.53 | 0.58 | 0.81 | 0.43 | 0.67 | 0.21 | 0.95 | 0.19 | 0.39 | 1.19 | 0.30 | 0.15 | 0.04 | 1.21 | 0.59 | 0.19 | 0.06 | 0.04 | 0.49 | 1.21 | 0.37 |
| | 0.57 | 1.86 | 1.27 | 1.90 | 2.47 | 0.87 | 2.49 | 0.45 | 1.19 | 0.88 | 1.01 | 0.85 | 0.04 | 0.10 | 0.34 | 0.58 | 0.15 | 0.78 | 2.08 | 0.03 | 0.58 | 0.26 | 0.03 | 0.94 | 2.49 | 0.75 |
| S | 0.85 | 1.10 | 4.83 | 2.33 | 0.12 | 2.24 | 1.16 | 0.96 | 2.44 | 1.03 | 1.48 | 0.48 | 0.82 | 0.83 | 1.52 | 0.35 | 1.30 | 0.57 | 2.24 | 2.03 | 1.09 | 0.69 | 0.12 | 1.38 | 4.83 | 1.00 |
| I | 2.55 | 2.61 | 1.62 | 0.64 | 2.31 | 1.63 | 0.06 | 0.91 | 0.49 | 1.62 | 3.11 | 0.35 | 0.14 | 1.49 | 0.62 | 3.46 | 2.43 | 2.16 | 0.78 | 0.96 | 0.12 | 4.15 | 0.06 | 1.55 | 4.15 | 1.14 |
| TAL | 10.90 | 14.57 | 19.71 | 14.53 | 17.02 | 14.92 | 13.73 | 14.62 | 10.59 | 10.90 | 12.69 | 11.74 | 14.37 | 11.33 | 16.46 | 12.12 | 11.75 | 11.05 | 14.73 | 10.16 | 13.17 | 6.34 | 6.34 | 13.06 | 19.71 | 2.76 |

**EAST MOUNTAIN TEMPERATURES - HISTORICAL SUMMARY**

| October Summary | HIGH | LOW |
|---|---|---|
| VG. | 49.57 | 33.03 |
| IAX. | 78.16 | 55.78 |
| IIN. | 11.60 | 4.29 |

| February Summary | HIGH | LOW |
|---|---|---|
| AVG. | 33.22 | 17.25 |
| MAX. | 57.21 | 39.99 |
| MIN. | -2.26 | -14.75 |

| June Summary | HIGH | LOW |
|---|---|---|
| AVG. | 68.64 | 46.18 |
| MAX. | 92.62 | 74.12 |
| MIN. | 27.73 | 13.09 |

| November Summary | HIGH | LOW |
|---|---|---|
| VG. | 35.84 | 23.14 |
| IAX. | 61.57 | 54.71 |
| IIN. | 6.59 | -4.76 |

| March Summary | HIGH | LOW |
|---|---|---|
| AVG. | 40.03 | 21.80 |
| MAX. | 70.86 | 49.75 |
| MIN. | 7.39 | -6.63 |

| July Summary | HIGH | LOW |
|---|---|---|
| AVG. | 76.19 | 53.73 |
| MAX. | 96.00 | 72.01 |
| MIN. | 48.47 | 20.39 |

| December Summary | HIGH | LOW |
|---|---|---|
| VG. | 29.36 | 15.25 |
| IAX. | 62.49 | 45.00 |
| IIN. | -2.64 | -17.61 |

| April Summary | HIGH | LOW |
|---|---|---|
| AVG. | 47.50 | 27.90 |
| MAX. | 77.22 | 52.90 |
| MIN. | 12.70 | -0.34 |

| August Summary | HIGH | LOW |
|---|---|---|
| AVG. | 73.53 | 52.44 |
| MAX. | 94.90 | 73.39 |
| MIN. | 35.77 | 31.85 |

| January Summary | HIGH | LOW |
|---|---|---|
| VG. | 31.02 | 16.63 |
| IAX. | 63.21 | 53.81 |
| IIN. | 1.95 | -15.19 |

| May Summary | HIGH | LOW |
|---|---|---|
| AVG. | 57.61 | 36.75 |
| MAX. | 89.03 | 64.32 |
| MIN. | 15.79 | 1.77 |

| September Summary | HIGH | LOW |
|---|---|---|
| AVG. | 63.54 | 43.49 |
| MAX. | 85.62 | 64.98 |
| MIN. | 31.60 | 17.55 |

| HISTORICAL SUMMARY - 1981 through 2009 | | |
|---|---|---|
| PARAMETER | DATE | TEMP |
| AVERAGE HIGH | NA | 50.50 |
| MAXIMUM HIGH | 07/13/02 | 96.00 |
| AVG. MAX. HIGH | NA | 77.41 |
| MINIMUM HIGH | 12/22/91 | -2.64 |
| AVG. MIN. HIGH | NA | 16.23 |
| AVERAGE LOW | NA | 32.30 |
| MAXIMUM LOW | 06/28/93 | 74.12 |
| AVG. MAX. LOW | NA | 58.40 |
| MINIMUM LOW | 12/22/90 | -17.61 |
| AVG. MIN. LOW | NA | 2.47 |

# Table 7-3
## COTTONWOOD CANYON CREEK WATER QUALITY *
## SW-1

| SAMPLE DATES | ACIDITY | ALKALINITY BICARBONATE | CALCIUM | CARBONATE | CHLORIDE | CONDUCTIVITY (umhos/cm) | HARDNESS | IRON TOTAL | IRON DISSOLVED | MAGNESIUM | MANGANESE | OIL & GREASE | PH (units) | POTASSIUM | SODIUM | SULFATE | TSS | TDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HISTORICAL 1977-2008 | | | | | | | | | | | | | | | | | | |
| MIN | 0.0 | 231 | 6.0 | 0.0 | 0.7 | 380.0 | 210.00 | 0.00 | 0.0 | 2 | 0.0 | 0.50 | 7.1 | 1.0 | 6.0 | 20.0 | 1 | 226 |
| MAX | 27.0 | 442 | 152.3 | 20.0 | 27.0 | 1026.0 | 541.0 | 15.90 | 0.4 | 78 | 1.3 | 358.00 | 8.7 | 21.0 | 60.0 | 238.7 | 1298 | 690 |
| MEAN | 5.7 | 337 | 67.1 | 5.6 | 12.5 | 690.7 | 343.1 | 0.82 | 0.1 | 40 | 0.1 | 11.10 | 8.0 | 2.8 | 20.2 | 75.8 | 65 | 386.8 |
| No. of Analysis | 46 | 91 | 90 | 21 | 91 | 52 | 58 | 81 | 19 | 91 | 64 | 41 | 86 | 87 | 90 | 91 | 81 | 91 |

* Quality parameters are reported as mg/l unless otherwise noted.

** Data: Database input restricted to values greater then laboratory minimum detection limit.

Table 7-4. USGS Water Quality Data at USGS Gaging Station on Cottonwood Creek above Straight Canyon, near Orangeville, Utah.

| Date | Oct 21 1978 | Nov 19 1978 | Jun 13 1979 | Jul 16 1979 | Aug 05 1979 | Sep 15 1979 |
|---|---|---|---|---|---|---|
| Time | 1130 | 1030 | 1430 | 1830 | 1630 | 1615 |
| Stream Flow, cfs | .33 | .57 | 3.3 | .94 | .54 | .32 |
| Specific Conductance, umhos/cm | 530 | 570 | 470 | 540 | 560 | 560 |
| pH | 8.7 | 8.9 | 7.8 | 8.8 | 8.7 | 8.6 |
| Temperature, C° | 8.5 | .0 | 17.0 | 17.0 | 19.5 | 13.5 |
| Oxygen (Dissolved), mg/l | 9.1 | 11.2 | --- | 7.4 | 7.0 | 8.2 |
| Coliform (Fecal), cols. 100 ml | --- | K13 | --- | --- | 24 | --- |
| Streptococci (Fecal), cols. 100 ml | --- | 81 | --- | --- | 2000 | --- |
| Hardness as CaCO3, mg/l | 300 | 300 | --- | 250 | 280 | 270 |
| Hardness as CaCO3 (Noncarbonate), mg/l | 30 | 16 | --- | 17 | 50. | 40 |
| Calcium (Dissolved), mg/l | 54 | 55 | --- | 39 | 40 | 42 |
| Magnesium as Mg (Dissolved), mg/l | 39 | 39 | --- | 38 | 44 | 41 |
| Sodium (Dissolved), mg/l | 14 | 13 | --- | 18 | 20 | 16 |
| Sodium (Percent) | 9 | 9 | --- | 13 | 13 | 24 |
| Sodium Absorption Ratio | .4 | .3 | --- | .5 | .5 | .4 |
| Sodium Potassium as Na (Dissolved), mg/l | --- | --- | --- | 20 | 26 | 18 |
| Potassium as K (Dissolved), mg/l | 2.9 | 1.9 | --- | 2.1 | 6.1 | 2.3 |
| Bicarbonate as HCO3, mg/l | 280 | 310 | --- | 260 | 260 | 260 |
| Carbonate as CO3, mg/l | 24 | 18 | --- | 14 | 10 | 10 |
| Alkalinity as CaCO3, mg/l | 270 | 284 | --- | 240 | 230 | 230 |
| Carbon Dioxide as CO2 (Dissolved), mg/l | 1.0 | .7 | --- | .7 | .9 | 1.1 |
| Sulfate as SO4 (Dissolved), mg/l | 49 | 44 | --- | 56 | 61 | 60 |
| Chloride as Cl (Dissolved), mg/l | 10 | 9.0 | --- | 8.9 | 11 | 9.1 |
| Fluoride as F (Dissolved), mg/l | --- | .1 | --- | --- | .2 | --- |
| Silica as SIO2 (Dissolved), mg/l | 6.9 | 6.9 | --- | 6.5 | 6.7 | 6.8 |
| Solids (Dissolved), tons per ac/ft | .46 | .47 | --- | .42 | .45 | .43 |
| Nitrate as N (Dissolved), mg/l | --- | .31 | --- | --- | .08 | --- |
| Nitrite as NO2 (Dissolved), mg/l | --- | .00 | --- | --- | .00 | --- |
| Nitrogen NO2 + NO3 as N (Dissolved), mg/l | --- | .31 | --- | --- | .08 | --- |
| Ammonia as N (Dissolved), mg/l | --- | .02 | --- | --- | .01 | --- |
| Organic Nitrogen as N (Dissolved), mg/l | --- | .22 | --- | --- | .13 | --- |
| Organic Ammonia as N (Total), mg/l | --- | .22 | --- | --- | .18 | --- |
| Organic Nitrogen NH4 (Total Suspended), mg/l | --- | .00 | --- | --- | .04 | --- |
| Ammonia + Organic Nitrogen (Dissolved), mg/l | --- | .24 | --- | --- | .14 | --- |
| Phosphorus as P (Total), mg/l | --- | .010 | --- | --- | .010 | --- |
| Phosphorus Ortho as P (Dissolved), mg/l | --- | .00 | --- | --- | .00 | --- |
| Phosphate Ortho as PO4 (Dissolved), mg/l | --- | .00 | --- | --- | .00 | --- |
| Boron as B (Dissolved), ug/l | --- | 50 | --- | --- | 60 | --- |
| Organic Carbon as C (Dissolved), mg/l | --- | 1.5 | --- | --- | 2.0 | --- |
| Organic Carbon as C (Total Suspended), mg/l | --- | --- | --- | --- | .1 | --- |
| Phenols, ug/l | --- | 3 | --- | --- | 0 | --- |
| Oil & Grease (Total), mg/l | --- | 0 | --- | --- | 0 | --- |
| Arsenic as As (Dissolved), ug/l | --- | 1 | --- | --- | 1 | --- |
| Chromium as Cr (Dissolved), ug/l | --- | 0 | --- | --- | 0 | --- |
| Iron as Fe (Dissolved), ug/l | --- | 10 | --- | --- | 0 | --- |
| Lead as Pb (Dissolved), ug/l | --- | 130 | --- | --- | 0 | --- |
| Lithium as Li (Dissolved), ug/l | --- | 10 | --- | --- | 20 | --- |
| Manganese as Mn (Dissolved), ug/l | --- | 2 | --- | --- | 1 | --- |
| Selenium as Se (Dissolved), ug/l | --- | 1 | --- | --- | 1 | --- |
| Strontrium as Sr (Dissolved), ug/l | --- | 320 | --- | --- | 370 | --- |
| Zinc as Zn (Dissolved), ug/l | --- | 3 | --- | --- | 3 | --- |
| Solids Sum of Constituents (Dissolved), mg/l | 338 | 342 | --- | 311 | 328 | 315 |
| Solids (Dissolved), tons/day | .30 | .53 | --- | .79 | .48 | .27 |

# Table 7-5

Utah Division of Health numerical standards for water in the state.

| Constituent | CLASSES: Domestic Source 1A | 1B | 1C | Recreation & Aesthetics 2A | 2B | Aquatic Wildlife 3A | 3B | 3C | 3D | Agriculture 4 | Industry 5 | Special 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bacteriological** (No./100 ml) | | | | | | | | | | | | |
| (30-day Geometric Mean) | | | | | | | | | | | | |
| Maximum Total Coliforms | 1 | 50 | 5,000 | 1,000 | 5,000 | * | * | | * | * | | |
| Maximum Fecal Coliforms | * | * | 2,000 | 200 | 2,000 | * | * | | * | * | | |
| **Physical** | | | | | | | | | | | | |
| Total Dissolved Gasses | * | * | * | * | * | (b) | (b) | | * | * | | |
| Minimum DO (mg/l) (a) | * | * | 5.5 | 5.5 | 5.5 | 6.0 | 5.5 | | 5.5 | * | | |
| Maximum Temperature | * | * | * | * | * | 20°C | 27°C | | * | * | | |
| Maximum Temp. Change | * | * | * | * | * | 2°C | 4°C | | * | * | | |
| pH | 6.5-9.0 | 6.5-9.0 | 6.5-9.0 | 6.5-9.0 | 6.5-9.0 | 6.5-9.0 | 6.5-9.0 | | 6.5-9.0 | 6.5-9.0 | | |
| Turbidity increase (c) | * | * | * | 10 NTU | 10 NTU | 10 NTU | 10 NTU | | 15 NTU | * | | |
| **Chemical** (Maximum mg/l) | | | | | | | | | | | | |
| Arsenic, dissolved | .05 | .05 | .05 | * | * | * | * | | * | .1 | | |
| Barium, dissolved | 1 | 1 | 1 | * | * | * | * | | * | * | | |
| Cadmium, dissolved | .010 | .010 | .010 | * | * | .0004(d) | .004(d) | | * | .01 | | |
| Chromium, dissolved | .05 | .05 | .05 | * | * | .10 | .10 | | .10 | .10 | | |
| Copper, dissolved | * | * | * | * | * | .01 | .01 | | * | .2 | | |
| Cyanide | * | * | * | * | * | .005 | .005 | | * | * | | |
| Iron, dissolved | * | * | * | * | * | 1.0 | 1.0 | | 1.0 | * | | |
| Lead, dissolved | .05 | .05 | .05 | * | * | .05 | .05 | | * | .1 | | |
| Mercury, total | .002 | .002 | .002 | * | * | .00005 | .00005 | | .00005 | * | | |
| Phenol | * | * | * | * | * | .01 | .01 | | * | * | | |
| Selenium, dissolved | .01 | .01 | .01 | * | * | .05 | .05 | | * | .05 | | |
| Silver, dissolved | .05 | .05 | .05 | * | * | .01 | .01 | | * | * | | |
| Zinc, dissolved | * | * | * | * | * | .05 | .05 | | * | * | | |
| $NH_3$ as N (un-ionized) | * | * | * | * | * | .02 | .02 | | * | * | | |
| Chlorine | * | * | * | * | * | .002 | .01 | | * | * | | |
| Fluoride, dissolved (e) | 1.4-2.4 | 1.4-2.4 | 1.4-2.4 | * | * | * | * | | * | * | | |
| $NO_3$ as N | 10 | 10 | 10 | | | | | | | | | |
| Boron, dissolved | * | * | * | * | * | * | * | | * | .75 | | |
| $H_2S$ | * | * | * | * | * | .002 | .002 | | * | * | | |
| TDS (f) | * | * | * | * | * | * | * | | * | 1200 | | |
| **Radiological** (Maximum pCi/l) | | | | | | | | | | | | |
| Gross Alpha | 15 | 15 | 15 | * | * | 15(g) | 15(g) | | 15(g) | 15(g) | | |
| Radium 226, 228 combined | 5 | 5 | 5 | * | * | * | * | | * | * | | |
| Strontium 90 | 8 | 8 | 8 | * | * | * | * | | * | * | | |
| Tritium | 20,000 | 20,000 | 20,000 | * | * | * | * | | * | * | | |
| **Pesticides** (Maximum ug/l) | | | | | | | | | | | | |
| Endrin | .2 | .2 | .2 | * | * | .004 | .004 | | .004 | * | | |
| Lindane | 4 | 4 | 4 | * | * | .01 | .01 | | .01 | * | | |
| Methoxychlor | 100 | 100 | 100 | * | * | .03 | .03 | | .03 | * | | |
| Toxaphene | 5 | 5 | 5 | * | * | .005 | .005 | | .005 | * | | |
| 2, 4-D | 100 | 100 | 100 | * | * | * | * | | * | * | | |
| 2, 4, 5-TP | 10 | 10 | 10 | * | * | * | * | | * | * | | |
| **Pollution Indicators** (g) | | | | | | | | | | | | |
| Gross Beta (pCi/l) | 50 | 50 | 50 | * | * | 50 | 50 | | 50 | 50 | | |
| BOD (mg/l) | * | * | 5 | 5 | 5 | 5 | 5 | | 5 | 5 | | |
| $NO_3$ as N (mg/l) | | | | 4 | 4 | 4 | 4 | | * | * | | |
| $PO_4$ as P (mg/l)(h) | * | * | * | .05 | .05 | .05 | .05 | | * | * | | |

STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS (SEE APPENDIX D)

STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS

STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS

Insufficient evidence to warrant the establishment of numerical standard. Limits assigned on case-by-case basis.

(a) These limits are not applicable to lower water levels in deep impoundments.

(b) Not to exceed 110% of saturation.

(c) For Classes 2A, 2B, 3A, and 3B at background levels of 100 NTUs or greater, a 10% increase limit will be used instead of the numeric values listed. For Class 3D at background levels of 150 NTUs or greater, a 10% increase limit will be used instead of the numeric value listed. Short term variances may be considered on a case-by-case basis.

(d) Limit shall be increased threefold if $CaCO_3$ hardness in water exceeds 150 mg/l.

(e) Maximum concentration varies according to the daily maximum mean air temperature.

| Temp. °C | mg/l |
|---|---|
| 12.0 and below | 2.4 |
| 12.1 to 14.6 | 2.2 |
| 14.7 to 17.6 | 2.0 |
| 17.7 to 21.4 | 1.8 |
| 21.5 to 26.2 | 1.6 |
| 26.3 to 32.5 | 1.4 |

(f) Total dissolved solids (TDS) limit may be adjusted on a case-by-case basis.

(g) Investigations should be conducted to develop more information where these pollution indicator levels are exceeded.

(h) $PO_4$ as P(mg/l) limit for lakes and reservoirs shall be .025.

## Table 7-6
## Surface Water Rights in the Vicinity of the Trail Mountain Mine

| Source | Claim No. | Owner | Use | Period | |
|---|---|---|---|---|---|
| Straight Canyon | 93-702 | USDA Forest Service | Stockwatering | June 1 - Oct. 15 | |
| Straight Canyon | 93-703 | Hunter Investment Group | Stockwatering | June 21 - Sept. 20 | |
| Straight Canyon | 93-704 | USDA Forest Service | Stockwatering | June 1 - Oct. 15 | |
| Cottonwood Creek | 93-708 | USDA Forest Service | Stockwatering | June 1 - Oct. 15 | |
| Cottonwood Creek | 93-709 | Trail Mountain Coal LDT | Mining/Industry | Jan. 1 - Dec. 31 | (See Appendix) |
| Cottonwood Creek | 93-710 | State Institutional Trust Lands Administration | Stockwatering | June 6 - Sept. 30 | |
| Cottonwood Creek | 93-711 | DOI Bureau of Land Management | Stockwatering | Jan. 1 - Dec. 31 | |
| Cottonwood Creek | 93-715 | USDA Forest Service | Stockwatering | June 1 - Oct. 15 | |
| Trail Mountain | 93-718 | USDA Forest Service | Stockwatering | June 1 - Oct. 15 | |
| Roans Canyon | 93-719 | USDA Forest Service | Stockwatering | June 1 - Oct. 15 | |
| Roans Canyon | 93-720 | USDA Forest Service | Stockwatering | June 1 - Oct. 15 | |
| | 93-721 | USDA Forest Service | Stockwatering | June 1 - Oct. 15 | |
| Straight Canyon | 93-800 | DOI Bureau of Land Management | Stockwatering | Jan.1 - Dec. 31 | |
| Straight Canyon | 93-802 | Jessie James Peacock | Stockwatering | Jan. 1 - Dec. 31 | |
| Straight Canyon | 93-803 | Jessie James Peacock | Stockwatering | Jan. 1 - Dec. 31 | |
| Cottonwood Creek | 93-1087 | Jessie James Peacock | Stockwatering | Jan. 1 - Dec. 31 | |
| Cottonwood Creek | 93-1088 | Jessie James Peacock | Irrigation | April 1 - Oct. 31 | 0.5 cfs |
| Cottonwood Creek | 93-1088 | Jessie James Peacock | Stockwatering | Jan. 1 - Dec. 31 | 0.25 cfs |

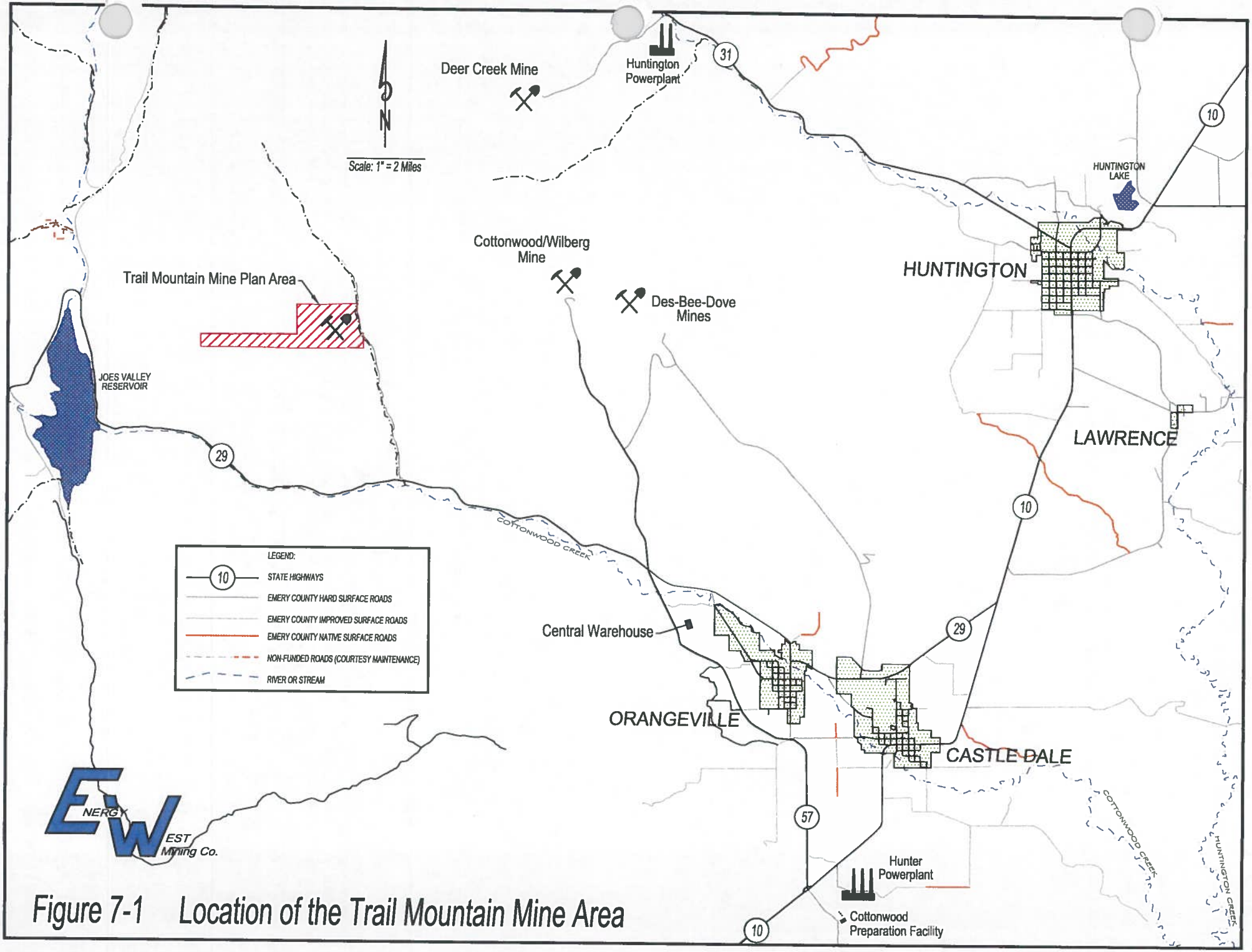



Figure 7-1 Location of the Trail Mountain Mine Area

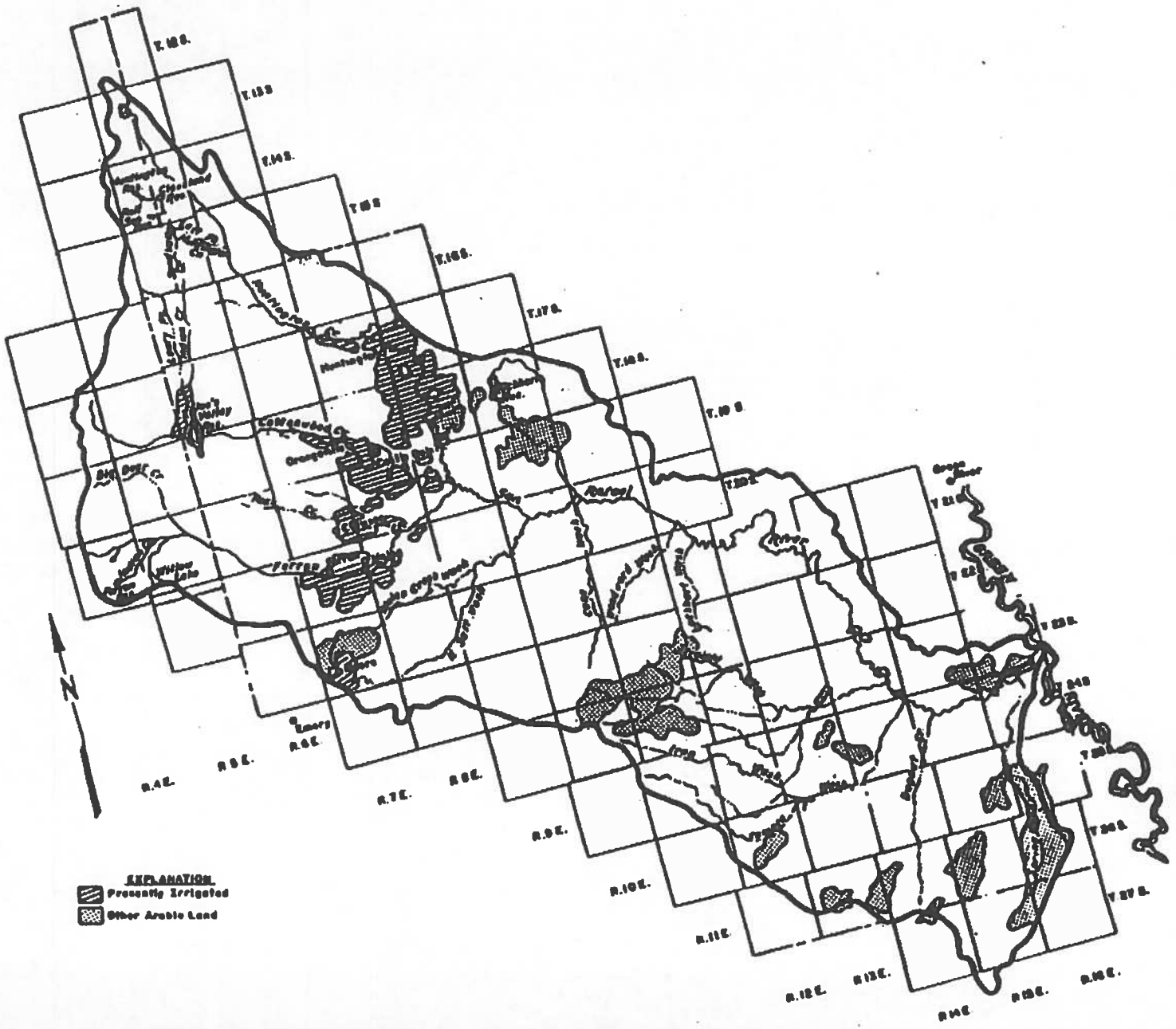



FIGURE 7-2 San Rafael River Basin (taken from Utah Division of Water Resources, 1974)

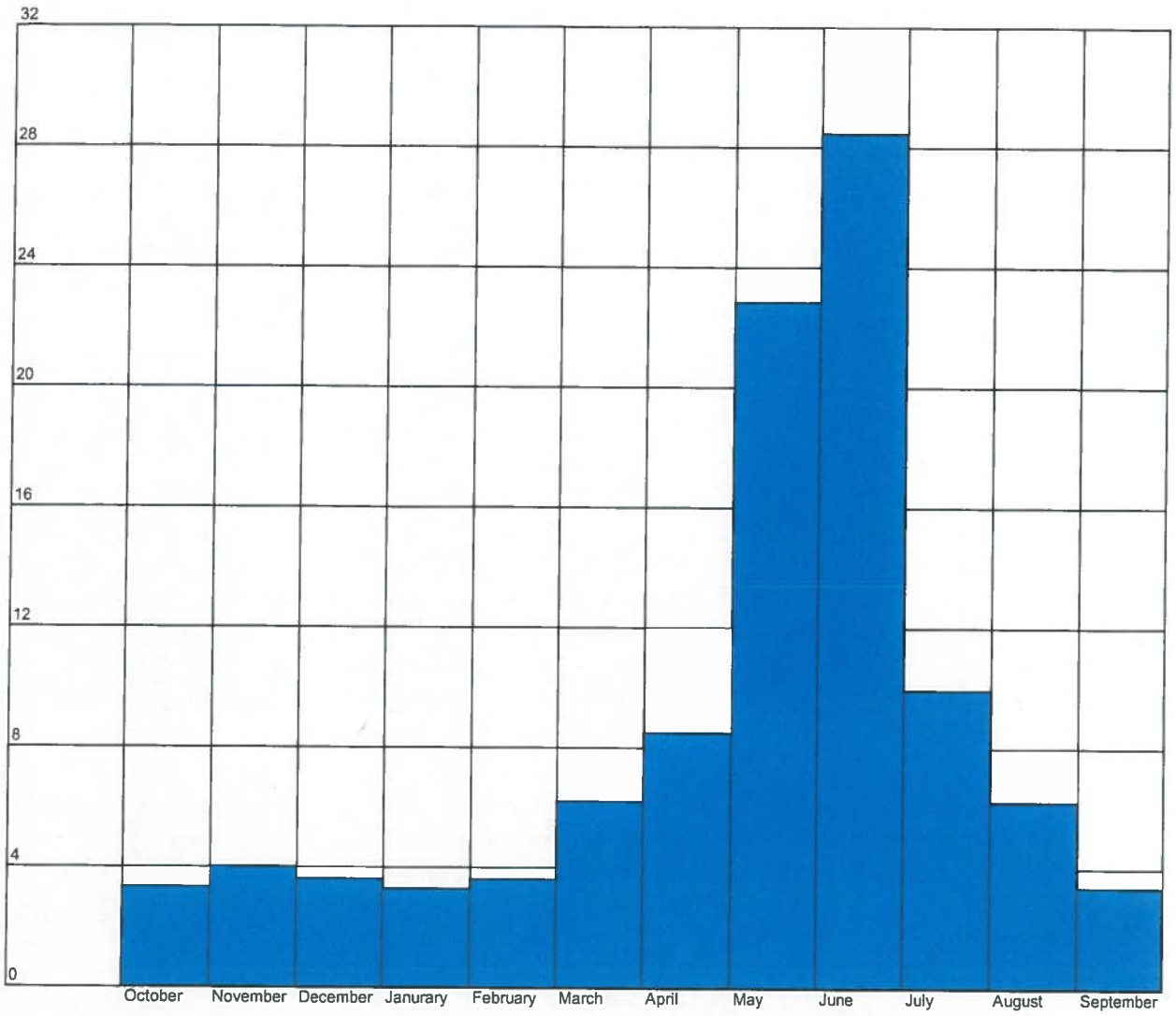
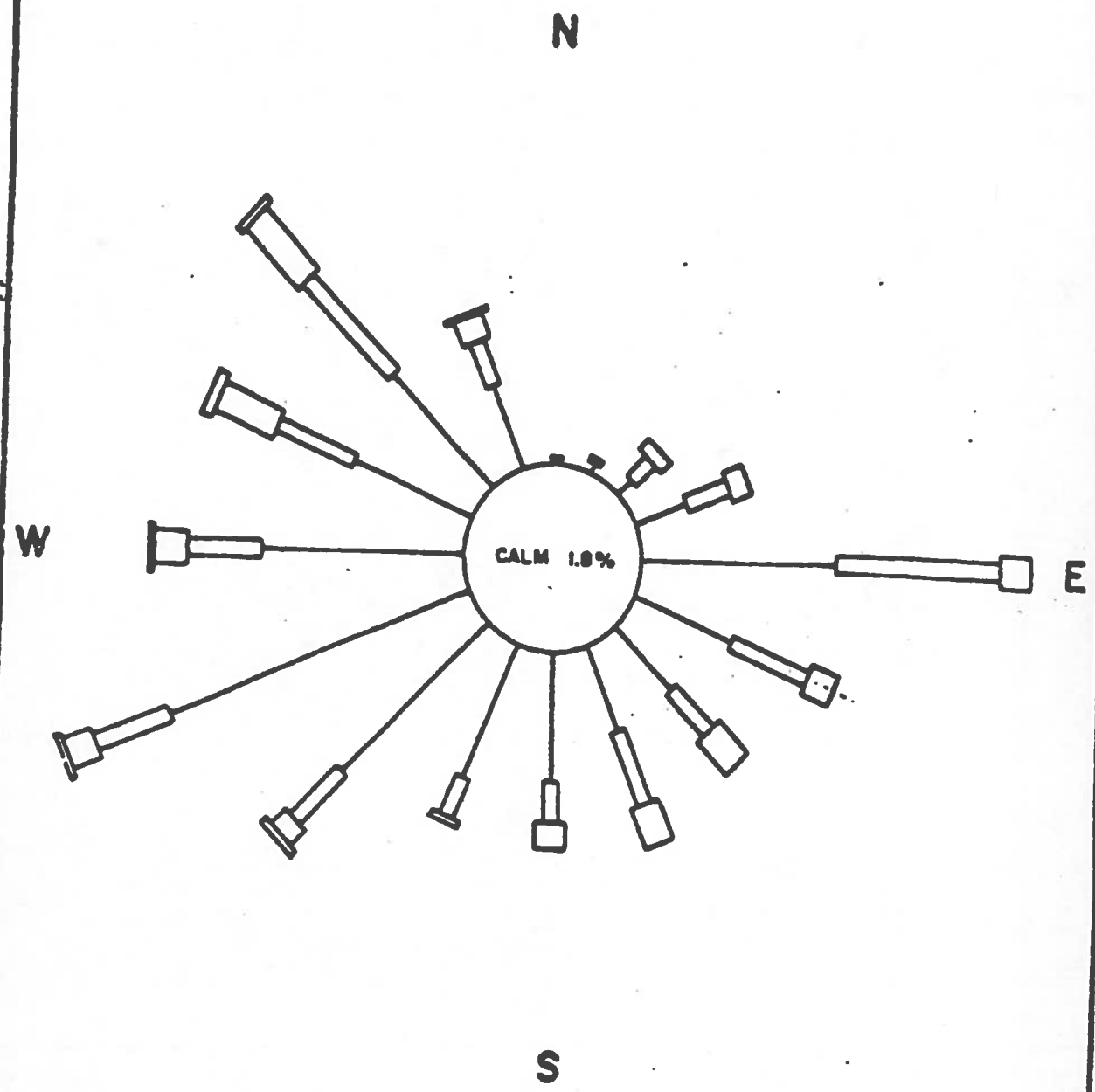



**Figure 7-3:** Monthly distribution of flows for Cottonwood Creek above Stright Canyon for the water year 1979 (October 1978 to September 1979). (from Water Resources Data for Utah. Part 1: Surface Water Records, 1979 USGS gaging Station 09324200)

# FIGURE 7-4




MEETINGHOUSE RIDGE JAN.-DEC. 1978

ALL TIMES

# APPENDIX 7-1

# WATER MONITORING PLAN

## APPENDIX 7-1 WATER MONITORING PLAN

| Monitoring Wells | Protocol |
|---|---|
| CCCW-1A | F, 6 |
| CCCW-2A | F, 6 |
| CCCW-3A | F, 6 |
| CCCW-1S | F, 6 |
| CCCW-3SU (shallow) | F, 6 |
| CCCW-3SL (deep) | F, 6 |
| TM-1B | E, 5 |
| TM-3 | E, 5 |
| CWRW-1 | F, 6 |
| **Streams** | |
| SW-1 | C, 4 |
| SW-2 | C, 4 |
| SW-3 | C, 4 |
| **Springs** | |
| T-10 (17-26-4) | B, 1 |
| T-14 | B, 1 |

**Field and Laboratory Measurement Protocol**

A Spring: Monitoring quarterly when reasonably accessible
B Spring: Monitoring 2nd, 3rd and 4th quarters only, when reasonably accessible
C Stream: Monitoring quarterly when reasonably accessible
D Stream: Monitoring 2nd, 3rd and 4th quarters only, when reasonably accessible
E Monitoring well: water measurement quarterly when reasonably accessible
F Monitoring well: water measurement 2nd, 3rd and 4th quarters only, when reasonably accessible

1 Groundwater field water quality measurements only
2 Groundwater field and operational laboratory water quality measurements
3 Surface-water field water quality measurements only
4 Surface-water field and operational laboratory water quality measurements
5 Well groundwater field water quality measurements only
6 Well water level measurements only

**Groundwater Operational Water Quality Lab Parameters and Field Measurements**

| FIELD MEASUREMENTS | REPORTED AS |
|---|---|
| Water Level or Flow | |
| pH | pH units |
| Specific Conductivity | µS/cm @ 25℃ |
| Temperature | ℃ |

| LABORATORY MEASUREMENTS | |
|---|---|
| Total dissolved solids | mg/l |
| Carbonate | mg/l |
| Carbonate (as $CaCO_3$) | mg/l |
| Bicarbonate (as $CaCO_{3)}$ | mg/l |
| Chloride | mg/l |
| Iron (dissolved) | mg/l |
| Iron (total) | mg/l |
| Magnesium (dissolved) | mg/l |
| Manganese (dissolved) | mg/l |
| Manganese (total) | mg/l |
| Potassium (dissolved) | mg/l |
| Sodium (dissolved) | mg/l |
| Sulfate | mg/l |

**Surface Water Operational Water Quality Lab Parameters and Field Measurements**

| FIELD MEASUREMENTS | REPORTED AS |
|---|---|
| Flow | |
| pH | pH units |
| Specific Conductivity | µS/cm at 25 ℃ |
| Temperature | ℃ |
| Dissolved Oxygen (perennial streams only) | mg/l |

LABORATORY MEASUREMENTS

| | |
|---|---|
| Total Dissolved Solids | mg/l |
| Total Suspended Solids | mg/l |
| Carbonate (as $CaCO_3$) | mg/l |
| Bicarbonate (as $CaCO_{3)}$ | mg/l |
| Calcium (dissolved) | mg/l |
| Chloride | mg/l |
| Iron (dissolved) | mg/l |
| Iron (total) | mg/l |
| Magnesium (dissolved) | mg/l |
| Manganese (dissolved) | mg/l |
| Manganese (total) | mg/l |
| Potassium (dissolved) | mg/l |
| Sodium (dissolved) | mg/l |
| Sulfate | mg/l |
| Oil and Grease | mg/l |

Baseline Lab Parameters will be added to groundwater or surface water parameters lists as needed to meet regulatory requirements.

## BASELINE LABORATORY MEASUREMENTS

| | |
|---|---|
| Aluminum | mg/l |
| Arsenic | mg/l |
| Barium | mg/l |
| Bicarbonate | mg/l |
| Boron | mg/l |
| Cadmium | mg/l |
| Chromium | mg/l |
| Copper | mg/l |
| Lead | mg/l |
| Mercury | mg/l |
| Molybdenum | mg/l |
| Nickel | mg/l |
| Nitrogen: Ammonia | mg/l |
| NO2 &NO3 | mg/l |
| Selenium | mg/l |
| Zinc | mg/l |

# APPENDIX 7-3

# HYDROLOGIC CONVEYANCE FACILITIES

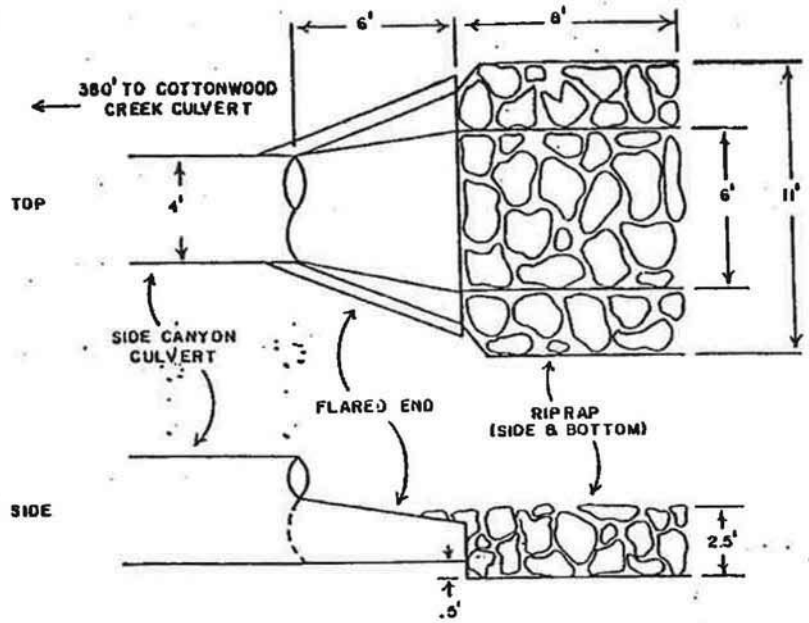
# APPENDIX 7-3

# HYDROLOGIC CONVEYANCE FACILITIES

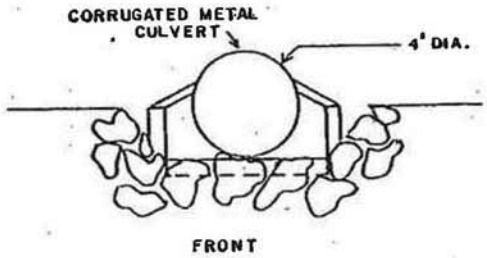
Conveyance Facilities

1. Inlet and Confluence of 48" Culvert
2. Culvert Specifications
3. Entrance and Exist Flow Velocities and Calculation for Cottonwood Creek
4. Riprap Structures (Width,Depth and Grain Size) For the following:
   (a) Cottonwood Creek Inlet Culvert and Outlet
   (b) Side Canyon Culvert Inlet
   (c) Reclaimed Cottonwood Creek
   (d) Reclaimed Side Canyon
5. Riprap Design and Calculations
6. Filter Blanket
7. Riprap Volumes

INLET AND CONFLUENCE OF 48" CULVERT

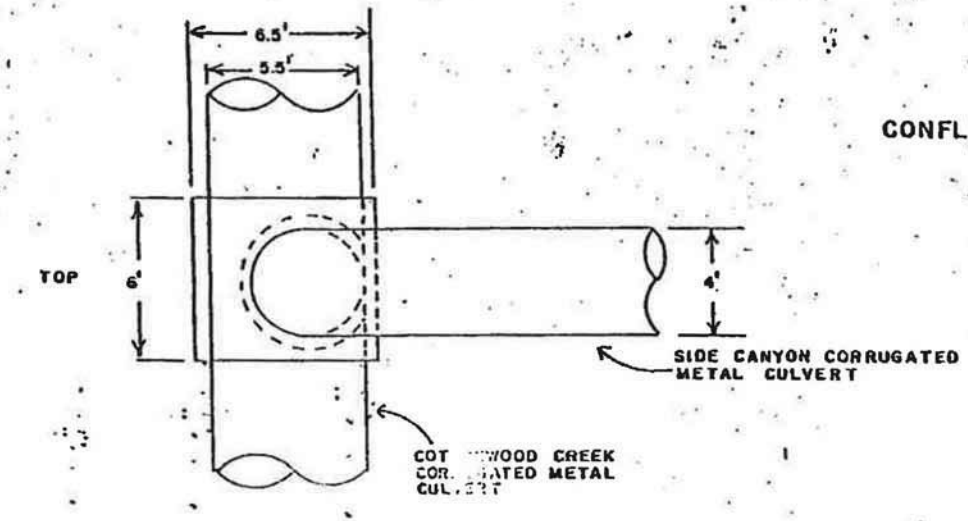



INLET SECTION OF THE SIDE CANYON CULVERT

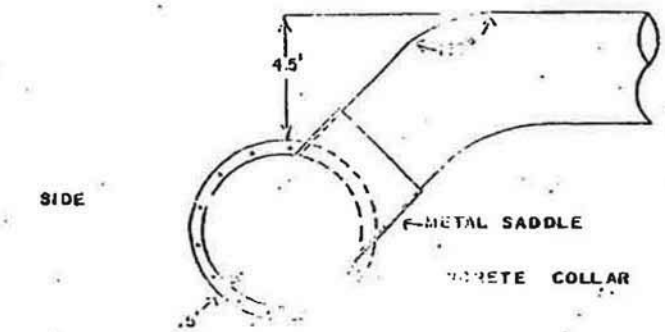



prepared by: MT. NEBO SCIENTIFIC
approved by: A.W. MILLER

## CONFLUENCE CULVERTS




380' TO SIDE CANYON CULVERT INLET →




prepared by: MT. NEBO SCIENTIFIC
approved by: A.W. MILLER

Beaver Creek Coal Company
Trail Mountain No.9 Mine

SPECIFICATIONS ON INSTALLED CULVERT

2/1/88

# PACIFIC CORRUGATED PIPE CO.

ISSUED BY:


OF SOUTHERN CALIFORNIA - FONTANA PLANT
13680 Slover Ave., Fontana, Calif. 92335
(714) 823-4286 - (213) 485-8811
SAN DIEGO (714) 298-3283
UTAH - (801) 768-8421
PHOENIX - (602) 248-2818

OF NORTHERN CALIFORNIA - SACRAMENTO PLANT
5999 Power Inn Road - PO Box 7405
Sacramento, California 95828
(916) 383-4891
UNION CITY - (415) 489-4744
REDDING - (916) 243-4564
FRESNO - (209) 441-1275

OF OREGON - SPRINGFIELD PLANT
2020 North 31st Street
Springfield, Oregon 97477
(503) 746-8474
PORTLAND - (503) 224-4817


PROPOSAL NO. _____

JOB: NATOMAS TROIL MOUNTAIN CANAL CO.

Bid Date:

Place: Time:

Terms: NET 30 DAYS

F.O.B.: MINE SITE

| ITEM | DESCRIPTION | UNIT | UNIT PRICE | TOTAL AMT. |
|---|---|---|---|---|
| 1. | 300' - 48" CSP .079 14ga | L.F. | 21.20 | |
| | ALTERNATE 48" CSP .109 12ga | L.F. | 28.53 | |
| | - 48" BAND COUPLERS (NO GASKET) | EA | 17.25 | |
| 2. | 3 - 48" CSP ELBOWS - APPROX 45° LABOR ONLY | EA | 168.00 | |
| 3. | 1 - 48" FLARED END SECTION | EA | 449.27 | |

48" CSP .064, 2 2/3 x ½ and band couplers 48" corrugated steel pipe .064 thickness per AASHTO M 36 sec. 1.1 corrugation- 2 2/3 x ½ spiral (2 2/3 pitch, ½" depth) per AASHTO M36 sec. 13 Copper Bearing Steel - per AASHTO M21 218

Quoted prices are good for ___ days and based on shipment of all materials within 3 months from time of order. Subsequent shipments shall be made at prices in effect at date of shipment. Shipping quantities and details as submitted are to be used as an aid in the preparation of your bid and should be considered as estimate only. Please check for accuracy as we do not assume this responsibility. Sales tax to be added if applicable.

Prices quoted are f.o.b. truck, stockpile jobsite, or as near to jobsite as truck can move under its own power. Contractor is to unload. Pipe will be nested whenever possible. The above prices are based on full truck load and/or truck and trailer load quantities. Additional freight will be charged for any extra loads resulting from the contractor's requesting less than truck and/or truck and trailer loads. THIS PROPOSAL IS MADE SUBJECT ONLY TO THE TERMS STATED ON THE REVERSE SIDE, AND THE SAID TERMS AND ANY SPECIAL PROVISIONS HEREINABOVE INSERTED SHALL CONSTITUTE THE SOLE AND ENTIRE AGREEMENT GOVERNING THE SALE OF ALL MATERIALS.

This proposal submitted on behalf of PACIFIC CORRUGATED PIPE CO. (Seller)

By _____ Date: 11/10/81

ENTRANCE AND EXIST FLOW VELOCITIES

AND

CALCULATION FOR COTTONWOOD CREEK

## HYDROLOGY

The stream channel upstream of the 96 inch Cottonwood Creek culvert has a typical cross-section with bottom width 6 or 7 ft and side slope Z of 0.5 horizontal to 1.0 vertical. The average bottom slope is approximately 10% and the rough, rocky, natural channel has an estimated Manning's n of 0.07. With the design peak Cottonwood Creek flowrate of 510 cfs (Table 7-7), the depth of flow would be approximately 4.5 ft and the velocity would be 12.2 fps (from Manning's eq.). Inside the 96 inch corrugated metal culvert with a Manning's n of 0.023 the 510 cfs would flow at a depth of approximately 4 ft (half full) and at a velocity of 20 fps.

Below the Cottonwood Creek culvert exit the typical cross-section has a b of 8 ft and Z of 1.5 with an approximate slope of 10% and n of 0.07. For the peak design flow of 510 cfs the depth would be approximately 3.4 ft and the velocity would be 11.4 fps. Inside the 66 inch corrugated metal culvert at 510 cfs the velocity would be near 25 fps.

For additional Cottonwood Creek culvert calculations and design information, see attached document from the Vaughn Hansen and Associates (from Chadwick to Hedberg).

October 9, 1981

Mr. Wayne Hedberg
Division of Oil, Gas, & Mining
1588 W. North Temple
Salt Lake City, Utah 84110

RE: Justification of culvert size used to pass 510 cfs flood on Cottonwood Creek

Dear Mr. Hedberg:

Andy King has asked that we submit our calculations showing that the culvert we designed for Cottonwood Creek has the capacity to pass the 50-year flood event. The U.S. Forest Service estimated the design flood to be 450 cfs. We have estimated it to be about 510 cfs and have designed the culvert with a capacity of about 535 cfs.

We have used the Darcy-Weisbach equation for estimating headloss in the culvert. This is considered as the most accurate headloss equation. As you may be aware, headloss through a culvert and entrance capacity of a culvert both need to be checked to determine actual capacity. When culverts are installed on fairly steep slopes (such as in the Natomas Trail Mountain case) the inlet capacity is much less than the capacity of the rest of the culvert. Consequently, in large, expensive installations on relatively steep slopes it is cost-effective to use a larger inlet than the main portion of the culvert. That is why we recommend using a 96-inch inlet which goes into a transition down to the 66-inch main culvert.

If you have any questions please feel free to call me.

Sincerely,

D. George Chadwick, Jr., P.E.

DGC/das

Enclosure

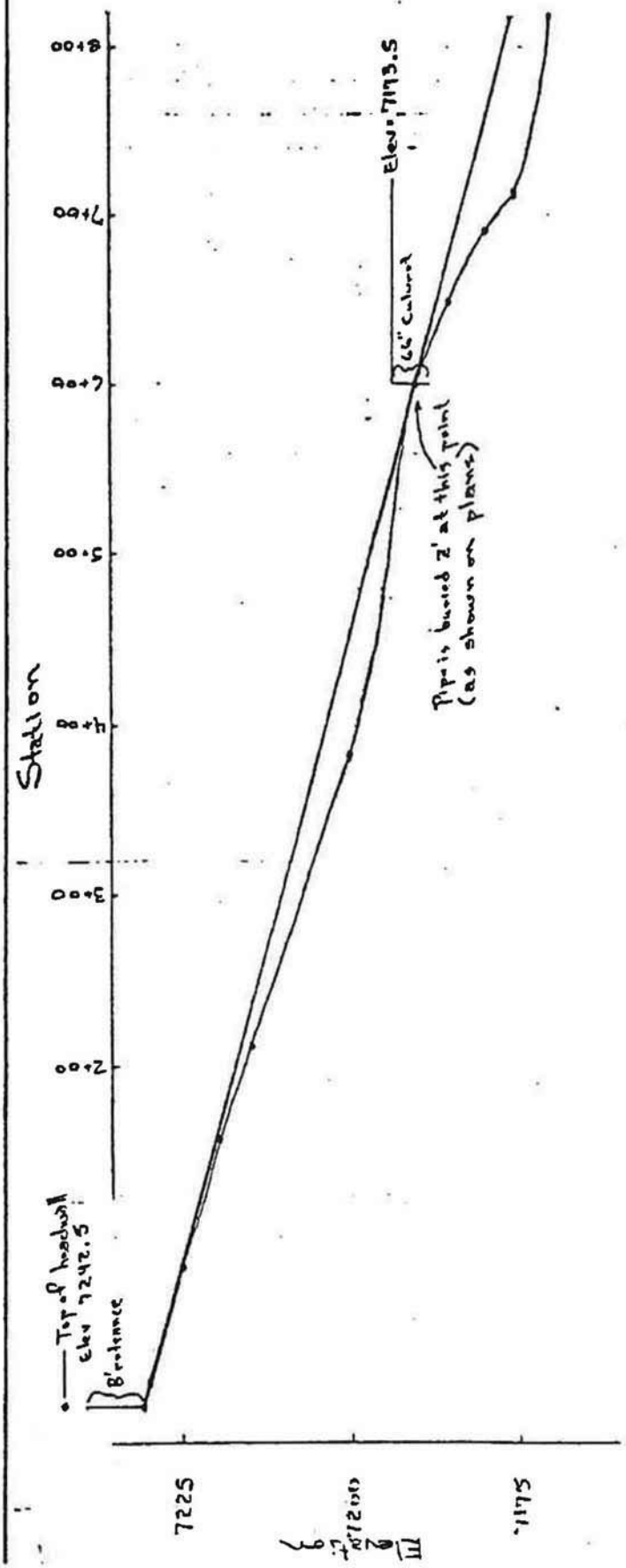
cc: Andy King

VAUGHN HANSEN ASSOCIATES
CONSULTANTS / ENGINEERS

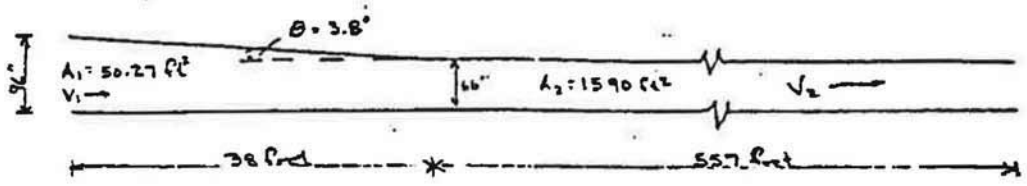
CHECKED _____ PROJECT _____

DATE 10-8-91 FEATURE Culvert Size

# Determination of Culvert Size needed to pass 510 cfs Flood on Cottonwood Creek




Governing section of pipe is from Sta 0+00 to 5+95
The allowable headloss through this section is 7242.5 - 7193.5 = 49 Feet




Using Darcy-Weisbach Equation

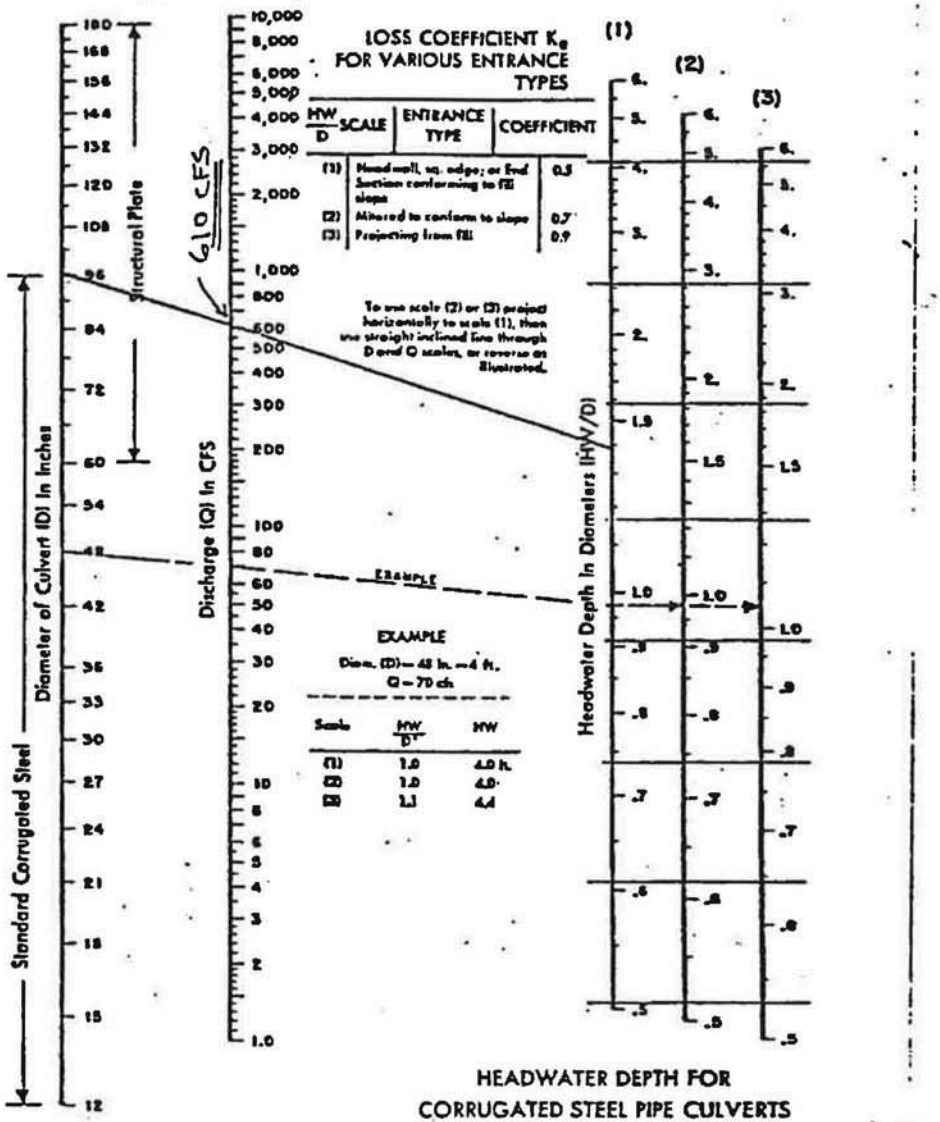
Minor Losses

| | K | Headloss ($H_L$) |
|---|---|---|
| Entrance loss | 0.25 | $H_L = 0.25 \frac{V_1^2}{2g}$ |
| Contraction | 0.11 | |
| Bends (2 @ 0.08ea.) | 0.16 | |
| Exit | 1.0 | |
| | $\Sigma = 1.27$ | $H_L = 1.27 \frac{V_2^2}{2g}$ |

Friction Loss

Headloss in a pipe is $\frac{f L}{D} \frac{V^2}{2g}$

The headloss in the 38 ft transition is approximated by the above formula when D = 6.5 ft




HEADWATER DEPTH FOR CORRUGATED STEEL PIPE CULVERTS WITH INLET CONTROL

Trial #1 Q = 450 cfs

$V_1 = \frac{450}{50.27} = 8.95$ fps

$V_2 = \frac{450}{23.76} = 18.94$ fps

V in 6.5' average transitional section is $\frac{450}{33.18} = 13.56$ fps

Minor losses = $.25\frac{(8.95)^2}{64.4} + 1.27\frac{(18.94)^2}{64.4} =$ 7.1 ft

Major losses

– 557 ft of 5.5' pipe

e = .1 $e/D = .1/5.5 = .018$ so $f = .047$

$H_L = (.047)\frac{(557)}{5.5}\frac{(18.94)^2}{64.4} =$ 26.5 feet

– 38 ft of 6.5' ave. dia. transition

$H_L = (.044)\frac{(38)}{6.5}\frac{(13.56)^2}{64.4} =$ .7 ft

Total Loss = 7.1 + 26.5 + .7 = 34.3 feet

Trial #2 Q = 535 CFS

$V_1 = \frac{535}{50.27} = 10.64$ fps V in 6.5' ave. trans. section is $\frac{535}{33.18} = 16.12$ fps

$V_2 = \frac{535}{23.76} = 22.52$ fps

Minor losses = $.25\frac{(10.64)^2}{64.4} + 1.27\frac{(22.52)^2}{64.4} =$ 10.4 ft

Major losses

– 557 ft of pipe $H_L = (.047)\frac{(557)}{5.5}\frac{(22.52)^2}{64.4} =$ 37.5 ft

– 38 ft of ave. diam. 6.5' transition

$H_L = .044\frac{(38)}{6.5}\frac{(16.121)^2}{64.4} =$ 1.0 ft

Total losses = 10.4 + 37.5 + 1.0 = 48.9 ft OK (because it is ≈ 49 ft available)

therefore **Capacity is 535 CFS**

Check inlet control of 96" Culvert. $\frac{Hw}{D} = 11/8 = 1.38$

From Nomograph. Capacity is 610 CFS so 535 cfs governs.

535 cfs is greater than the 510 cfs required.

# RIPRAP STRUCTURES

HYDROLOGY

(1) The riprap located in the entrance and exit channels of the Cottonwood Creek culvert is much more than sufficient to withstand the 10 fps velocities incurred during peak runoff flows. The riprap has been placed 60 ft upstream from the culvert entrance and 15 ft up the banks (compared to the 5 ft depth at peak runoff). The largest rocks are 10 ft across. Most are between 4 and 6 ft. In between these larger boulders the space is filled with 6 to 12 inch rocks 2 to 3 ft deep. Sizes are $D_{84}$ = 9 ft, $D_{50}$ = 5 ft, and $D_{16}$ = 0.5 ft. The bed material under the riprap is medium to coarse gravel along with broken rock from the riprap. This material forms an adequate filter blanket to prevent erosion and scour from around the riprap. The natural soil is sandy (see Table 8-1, p. 8-8).

Downstream from the culvert the riprap length is 50 ft and the banks are protected up 12 ft (compared to the 4 ft peak runoff depth). Sizes are $D_{84}$ = 6 ft, $D_{50}$ = 3 ft, and $D_{16}$ = 0.5 ft. The riprap here also is underlain with gravel, broken riprap, and sandy soil which serve as an adequate filter blanket. Up to 2 ft of smaller rocks are located in between the layer rocks.

(2) The Side Canyon culvert inlet has 8 ft of riprap upstream from the 6 ft long metal wing wall section. Sizes are $D_{84}$ = 12 in, $D_{50}$ = 6 in, and $D_{16}$ = 4 in. The riprap is 2 ft on each bank and across the 4 ft bed width. There are some smaller rocks below the riprap and the soil is coarse sand with some fines. During the highest runoff last year some sediment (mostly pine bows and silt) deposited on the riprap. This was cleaned from the wing wall extension and inspection of the entrance is made monthly.

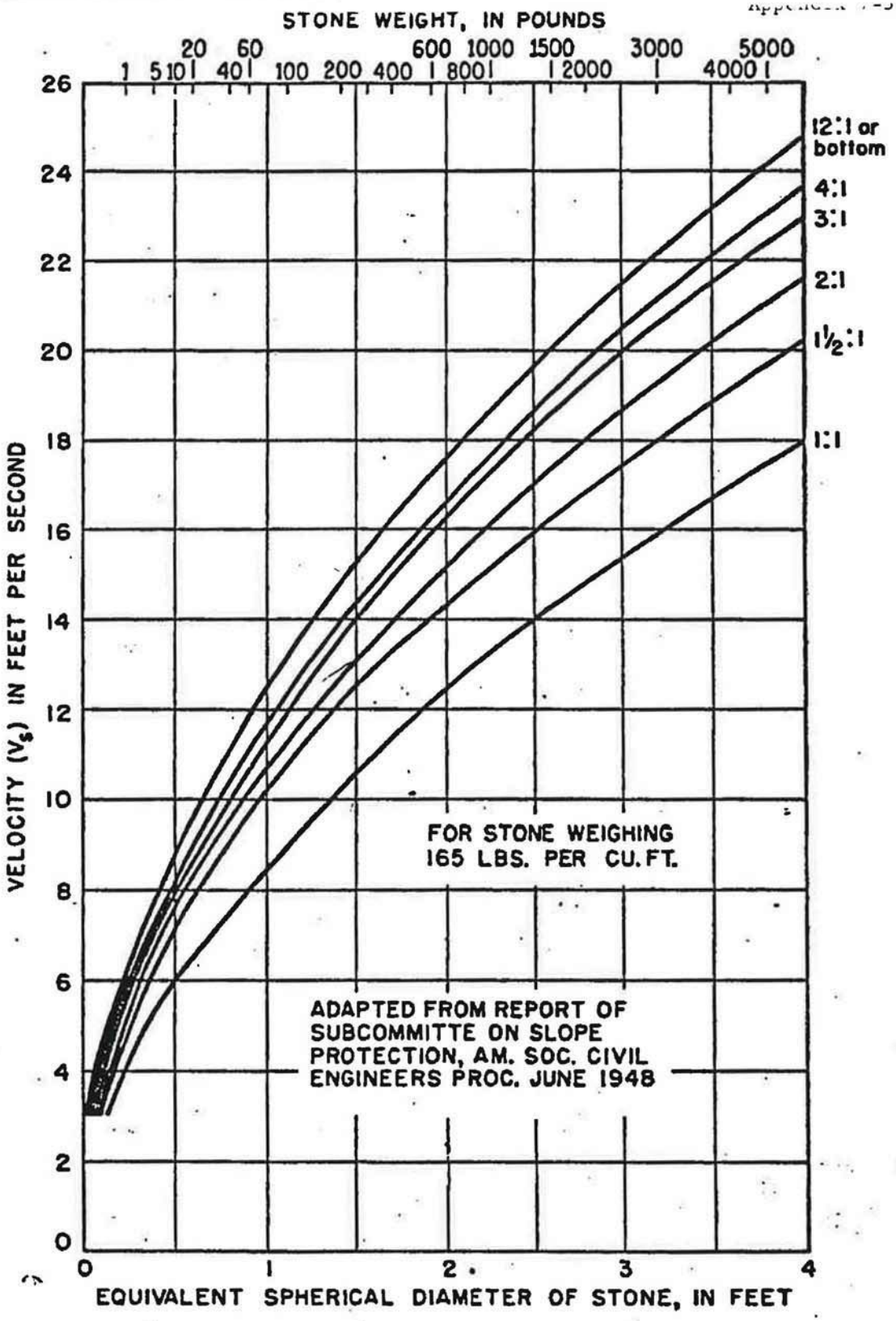
# RIPRAP DESIGN AND CALCULATIONS

Riprap Design and Calculations

Rock riprap is usually the most economical material for bank protection and is easily repaired when local damage occurs.[1] Dumped stone riprap will be used for bank protection on both Cottonwood Creek and the "unnamed tributary", herein referred to as the Side Canyon. Riprap design has been calculated for the 100 year, 24 hour event. Peak flow rates (Q values) during this event are as follows: 1) Cottonwood Creek 710 $ft^3/sec$ and 2) Side Canyon 160 $ft^3/sec$.

Stone sizes needed to protect streambank from erosion were determined by use of Graph 2[2]. Mean velocity (Vm) of the stream during the design flood and mean velocity against the stone (Vs) were calculated yielding a median stone size of 1.4 ft in diameter for Cottonwood Creek and 1.0 ft in diameter for Side Canyon. Size (K) is the diameter in feet of a spherical stone having the same weight as the 50% (median) size of stone. The procedure and calculations deriving these values we included in the subsequent page.

Considerable amounts of acceptable stone size exist on the permit area and have been used in the past for riprapping the culverts and sedimentation pond along Cottonwood Creek. During earthmoving procedures, potential riprap




GRAPH 2.-SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

2/15/90

will be sorted and set aside.

Both reclaimed stream channels will assume a trapezoidal configuration. Bottom width of the stream channel for Cottonwood Creek and Side Canyon will be 7 ft and 2 ft respectively. The corresponding banks will be contoured to approximately 2:1 (27 degree) slope and will be compacted with the backhoe prior to dumping riprap. Riprap will be dumped into the channel (frontend loader) and distributed along the channel banks. Riprap will be placed 4.5 ft high along the banks of Cottonwood Creek and 2.8 ft along the banks of Side Canyon. The entire channel will be riprapped unless the channel bottom turns out to be on bedrock. The riprap will extend approximately 8 inches above the design high water level for both stream channels.

Control of gradation will be made by visual inspection. Pockets formed by larger stones will be filled with smaller sized stones. At intervals along the channel bottom of Cottonwood Creek, boulders (approximately 3-4 ft in diameter) will be placed creating check dams and areas where water can pool. This will create a more natural setting and provide additional habitat for aquatic organisms. Similar procedures will be conducted along Side Canyon. Boulder size will not exceed 1.5 ft in diameter in Side Canyon. The check dams are

not intended to control sedimentation or erosion, but to enhance the stream habitat; therefore, no specific hydrologic designs are established for this item.

During reconstruction of the main channel, it is proposed to divert the Cottonwood Creek flow around the minesite. This will be accomplished by installation of a small, temporary dam in the channel with a pump diverting the flow into a flexible culvert (or other conveyance structure), which will discharge either back into to culvert below or into the channel below the pond.

A special mixture of grasses (some sod-forming), forbs, shrubs and trees will be planted along the vertical limits and under the riprap (see riparian seed list). After a period of time, vegetation will establish between the rocks giving a more natural appearance. The riparian community will extend 20-40 ft on the west side of the stream channel and approximately 20-25 ft on the east side of the channel depending upon the location of the road.

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[1]USDA, Soil Conservation Service, 1954. "Handbook of Channel Design for Soil and Water Conservation". SCS-TP-61 Washington, D.C., pp. 1-34.

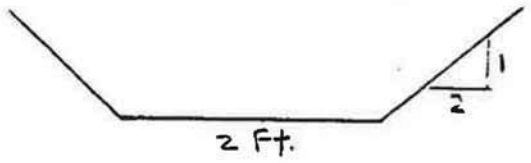
[2]U.S. Dept. of Transportation, 1967. "Use of Riprap for Bank Protection". Hydraulic Engineer. Circular No. 11. Washington, D.C., pp. 1-43.2

## Riprap Calculations

## Side Canyon

1) Determine Slope $S = 8\%$

2) Assume trapedzoidal configuration with: $b = 2$ & $z = 2.0$




3) Use Manning's equation to determine depth given:

$Q = 160 \text{ ft}^3/\text{sec}$

$S$: Above

$\alpha z$: Above

$n = 0.04$

use program to calculate $y$

$y = 2.16$ ft

4) $A = (2 + 2(2.16))\, 2.16 = 13.69$

$V = 160/13.69 = 11.69$ fps

5) Refer to graph 2 where average velocity is used for side velocity ($V_s$) in order to yield most conservative estimate for riprap size

$V = 11.69 \rightarrow D_{50}$ 1.0 ft

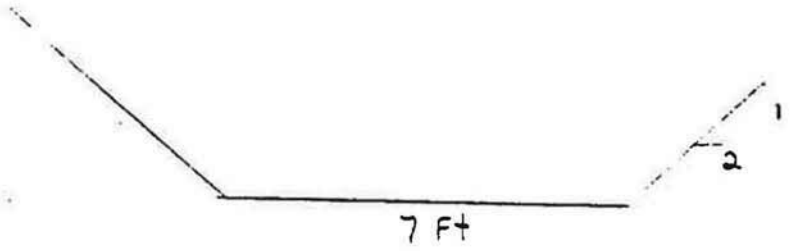
$D_{15}$: 0.25 ft  $D_{50} = 1.0$ ft  $D_{85} = 1.5$ ft

Riprap Calculations

Cottonwood Creek

1) Determine Slope S = 6%

2) Assume Trapezoidal configuration b = 7Ft. & Z: 2.0




3) Use Manning's equation to determine depth given:

Q = 710 $Ft^3/sec$

S = Above

b&z: Above

n = 0.05

Use program to calculate y

y = 3.81'

4) A: $(7 + 2(3.81))\ 3.81 = 55.59\ Ft^2$

V = 710/55.59/ = 12.77 fps

5) Refer to graph 2 where average velocity is used for size velocity ($V_s$) in order to yield most conservative estimate for riprap size V = 12.8 ⟶ D50 1.4 ft

$D_{16}$ = 0.3 Ft  D50 = 1.4 Ft  $D_{84}$ = 2.2 Ft

FILTER-BLANKET

Filter-Blanket

A blanket of well-graded gravel will be placed over all reclaimed stream beds and sides (Cottonwood Creek and Side Canyon Creek) prior to riprap palcement. Sizes of durable particles in the filter blanket will be from 5 mm (3/16 inches) to an upper limit depending on the gradation of the riprap. Thickness of the filter will be 6 to 12 inches or up to a thickness of D max of the filter. No more than 5% of the particles should be finer than a 200 mesh sieve.

Erosion may occur under the riprap lining causing voids and cavities. This loss of support could cause riprap failure.

Use of the properly designed filter layer will minimize this occurence and greatly increase riprap stability. Suitable soil and rock for the filter can be obtained from the riprap placement operations and from the local hillside and stream bed material.

RIPRAP VOLUMES

Riprap Volumes

Reclamation of Cottonwood Creek will involve 1,800 ft of riprap (median diameter = 1.4 ft) that will enventually support part of the reclaimed riparian plant community. The riprap of Cottonwood Creek will be placed to a depth of 4.5 ft to accomodate the 100-year, 24-hour event (described previously). Since a 4 ft depth is necessary (at 27°), the riprap surface area will be 10.0 ft. Calculations of riprap volume resulted in 1,867 $yds^3$ of material necessary for the Cottonwood Creek Stream channel.

The side canyon channel will be 265 ft long, perpendicular to Cottonwood Creek. To accomodate the aforementioned storm, a depth of 2.8 ft is necessary with a 27° slope. The riprap surface will then be 6.2 ft. The volume of riprap with medial diameter o 1.0 ft is 122 $yds^3$. Therefore total volumes of riprap for reclamation of the stream channels on the Trail Mountain Coal mine is 1,989 $yds^3$.

APPENDIX 7-4

RIP-RAP DESIGN

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# APPENDIX 7-4

## RIPRAP DESIGN
(Existing Riprap Only)

Riprap size has been determined based on expected velocitits. The curve given in "Hydrologic Design of Stilling Basins and Energy Dissipators", U.S. Bureau of Reclamation, Engineering Monograps #25 for stone diameter versus bottom velocities is used. Riprap has been sized larger than nine inches in all cases to resist velocities of 8 fps of less. All calculated velocities (e.g. Table 7-8) are less than 8 fps and most are less than 5 fps. Depth and width of the riprap placement is in accordance with the UDOGM regulations.

A size distribution analysis has been made on the soil near the riprap with the following results:

| | | | | |
|---|---|---|---|---|
| Cottonwood Creek Inlet | 60% | < | 2mm | |
| | 2mm | < | 6% | 5mm |
| | 34% | > | 5mm | |
| Cottonwood Creek Outlet | 74% | < | 2mm | |
| | 2mm | < | 8% | 5mm |
| | 18% | > | 5mm | |

From this analysis and the fact that velocities are less than 5 fps is was determined that no filter blanket below the riprap would be necessary.

All riprap at the Trail Mountain Mine site is composed of a well graded mixture of riprap with the majority of stones being one foot and larger. Riprap is palced in a layer 1.5 times (or more) as thick as the largest stone diameter. (see following attachment).

2/15/90

700 pounds, 90 percent finer than 400 pounds, 80 percent finer than 200 pounds, 50 percent finer than 80 pounds, 40 percent finer than 35 pounds, 24 percent finer than 9 pounds. Subjected to velocity of from 10 to 14 feet per second. Failure at 13.3 feet per second, based on discharge divided by flow area.

*Point 2F*

Riprap on banks and bottom; failure was general on banks and bottom—it is not known which occurred first. Riprap size analysis: 100 percent finer than 500 pounds, 90 percent finer than 350 pounds, 80 percent finer than 260 pounds, 50 percent finer than 80 pounds, 40 percent finer than 45 pounds, 20 percent finer than 10 pounds. Subjected to velocities up to 23 feet per second. Failure occurred after sustained average velocity of 16.3 feet per second.

*Point 3F*

Riprap failure on banks of channel, slope 1:1 approximately and flatter. Riprap size 90 percent finer than 410 pounds. Failure was rapid at a velocity of 16.5 feet per second.

*Point 4F*

Riprap failure on flat sloping banks. Riprap was 12-inch-thick layer, 50 percent of rock was 20 to 90 pounds (remainder spalls). Continual maintenance required above 10 feet per second and believed to be marginal at just less than 10 feet per second.

*Point 5F*

Riprap failure on bottom of channel. Material consisted of 18-inch-thick layer of rocks averaging 100 pounds (few larger pieces). Resisted 12 feet per second for a time but eventually failed.

*Point 6F*

Riprap failure on steep bank projecting into current. Six-inch cobbles placed about two stones deep. Complete failure at 12 feet per second.

*Point 1S*

Riprap on 1½:1 banks, 10 feet high, stood up well with only occasional maintenance. Mixture of 1,000- and 2,000-pound stones; smaller pieces often on surface. Flow velocity 14 feet per second in center of channel; velocity near riprap estimated at 12 feet per second. No filter or bedding but riprap was placed on natural sand.

*Point 2S*

Hand-placed stone about 500 pounds each. Resisted 12 feet per second, required maintenance at greater unknown velocity.

*Point 3S*

Dumped riprap fill, 100 pounds maximum weight, resisted 6 to 9 feet per second for indefinite period.

*Point 4S*

Flat paving of 10- to 12-inch stones below a canal headgate resisted a velocity of 6 to 7 feet per second for many years.

*Point 5S*

This is actually two points, as shown on graph. In a natural mountain stream in flood, 1,000-pound stones moved under 14 feet per second velocity; 2,000-pound stones did not.

## Conclusions

The passage of the flood of August 20 through the two outlet works structures of the Picacho Arroyo control indicates that the prototype performance was as predicted by the hydraulic model tests described in Section 6. Despite the fact that the general design rules presented limit the incoming velocity to 30 feet per second, the North and South Dams structures performed very well for velocities computed to be about 37 and 32 feet per second, respectively, with discharges equal to 80 percent of design capacity. The only adverse performance of these structures was the loss of the riprap below the North Dam outlet works. This loss was shown to be consistent with the curve in Figure 165.

The outlet works structures at the North and South Dams appear, offhand, to be of about the same general size, both in physical dimensions and in the quantity of water to be handled. On this basis, riprap sizes for both structures were specified to consist of material from ¼ cubic yard to ⅛ cubic foot. On the North Dam outlet works this material was entirely removed from the channel bottom by outflow having a velocity of about 12 feet per second. Below the South Dam outlet works the same material remained in place with an outflow velocity of about 5 feet per second, considerably lower than at the North Dam. There-

fore, it is evident that the minimum stone sizes are critical with respect to the velocity below the structure. Stone size in a riprap layer used for channel bank or bottom protection is indicated by Figure 165 It is felt that this curve, even though only partially proven by the "F" and "S" points, will provide a starting point for the development of a more accurate method of determining stone sizes and specifying riprap mixtures. The curve indicates over most of its range that doubling the flow velocity leaving a structure makes it necessary to provide riprap about 4 times larger in nominal diameter or 16 times larger in volume or weight. These factors alone provide a basis for thought in specifying riprap material.

## Recommendations

The riprap sizes given in Table 11, Column 19, are based on the data and discussions presented here. For other types of stilling basins use the bottom velocity if known, or the average velocity based on discharge divided by cross-sectional area at the end sill of the stilling basin, to find the maximum stone size in Figure 165. Specify riprap so that most of the graded mixture consists of this size. Place the riprap in a layer at least 1½ times as thick as the maximum stone size. It is a fairly well established fact that better performance of the riprap results when it is placed over a filter, or bedding, composed of gravel or graded gravel having the larger particles on the surface.

FIGURE 174.—*Surge-type waves extracted fine earth material from behind coarse riprap, causing entire mass to settle away from top of bank. High water line was below elevation where man stands.*

Figure 174 shows an installation of oversized riprap laid directly on fine soil. The riprap has partially failed because waves removed material from beneath the riprap layer. The top of the riprap was originally at the top of the bank. A filter layer would have prevented settlement.

---

Following this text are:

1. Bibliography
2. Nomograph
3. Pictorial Summary

Works listed in the Bibliography supplied both source and reference material for this monograph, although most of the material contained herein is original in nature.

The Nomograph will be found to be extremely useful in solving hydraulic jump problems, particularly on a first-trial basis. The rate of change of the variables to be seen by manipulating a straightedge can be of definite help to both student and design engineer.

The Pictorial Summary is particularly useful in locating a particular item in the monograph or for suggesting the proper structure for a given set of conditions.

APPENDIX 7-5

MINE FLOW CALCULATIONS

# APPENDIX 7-5

# MINE INFLOW CALCULATIONS

EarthFax Engineering, Inc.
Engineers/Scientists

December 19, 1986 C-54

Mr. Allen P. Childs
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537-0370

Dear Allen:

Pursuant to your request, we have reviewed the statement made in Chapter 7 of the Tract 2 permit application package (PAP) regarding potential inflows to the mining operations. Apparently, an important figure used to determine the expected inflow rate was inadvertently omitted from the PAP. This figure (reproduced herein as Figure 1) was developed by Lines (1985) based on the results of analyses using a three-dimensional, finite-difference model (McDonald and Harbaugh, 1984) to determine drawdown effects from mining operations in the Trail Mountain area.

As noted by Lines (1985), his modeling results are based on assumed hydraulic conductivities of 0.01 and 0.02 foot per day for the Blackhawk Formation and the Star Point Sandstone, respectively. He further assumed that the formations acted as a single aquifer and that the aquifer was isotropic. Drawdown effects were modeled for various mine widths and lengths based on selected premining hydraulic gradients.

According to Lines (1985) and data presented in Figure 7-1 of the PAP, the premining hydraulic gradient in the vicinity of the Trail Mountain Mine is 0.04 foot per foot. Entering Figure 1 with this gradient and a mine length and width of 9000 feet and 5000 feet, respectively, the steady-state mine inflow was determined to be 0.15 cfs (approximately 70 gpm).

Lines (1985) indicates that the model results represent "order-of-magnitude estimates of mine inflow . . ." but that "the estimates are more reliable than those that could be made with other more simplified analytical techniques." Thus, although the actual inflow may vary slightly due to local changes in the hydraulic properties of the aquifer, the inflow estimate of 70 gpm is considered adequate for this investigation.

It was noted in the PAP that the 70 gpm estimate is based on the mine workings encountering fully saturated bedrock. Since this will not be case throughout the mine, the estimated inflow probably represents a maximum value. Additionally, the lack of known fractures in the vicinity of the mine reduces the potential for major unanticipated inflows.

If you have any questions regarding our explanation, please contact us.

Sincerely,

Rich

Richard B. White, P.E.
Principal Hydrologist

Enclosure (Figure 1)

References

Lines, G.C. 1985. The Ground-Water System and Possible Effects of Underground Coal Mining in the Trail Mountain Area, Central Utah. U.S. Geological Survey Water-Supply Paper 2259.

McDonald, M.G. and A.W. Harbaugh. 1984. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model. U.S. Geological Survey Open-File Report 83-875.

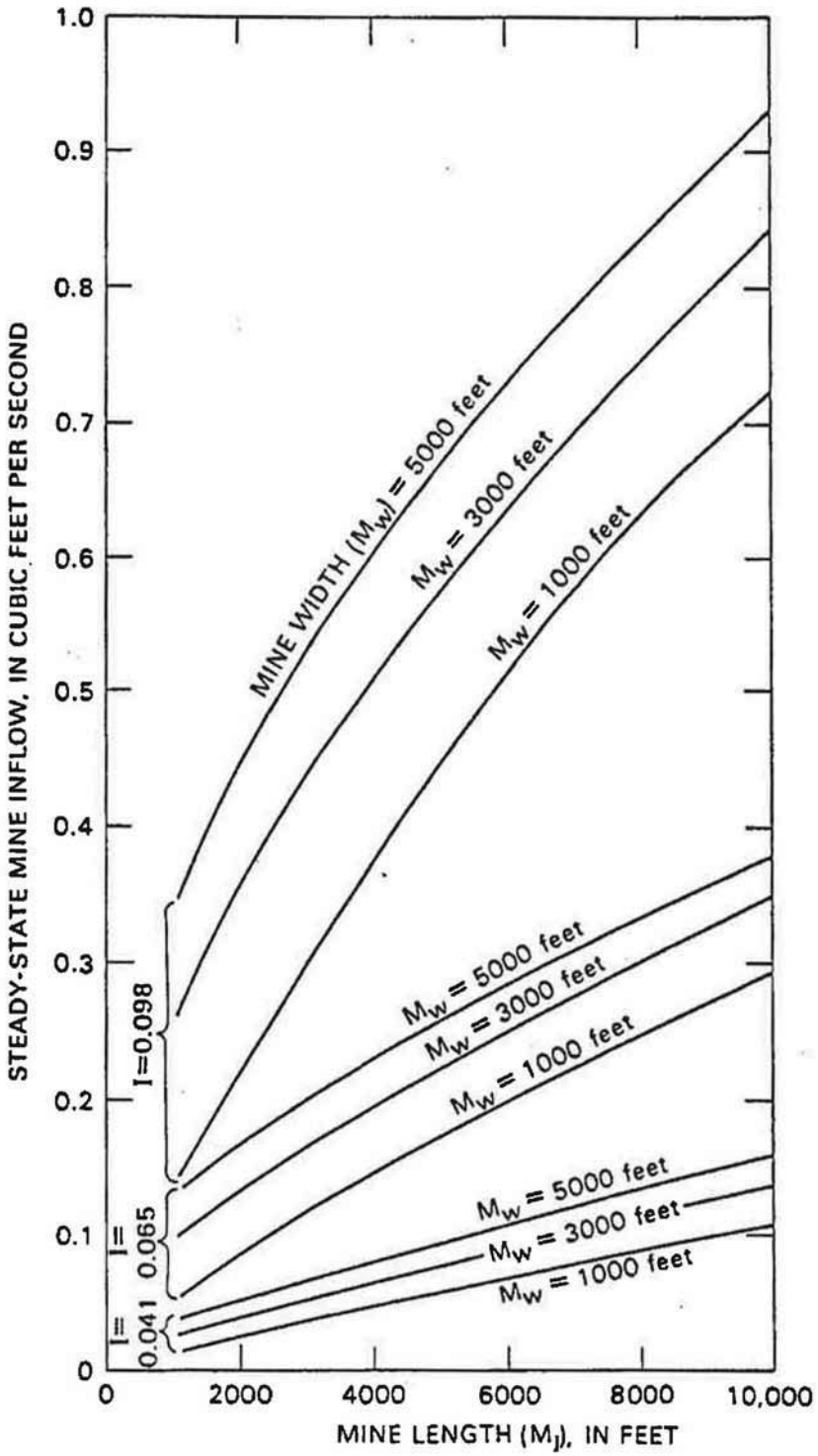



Figure 1. Variation in mine-water inflow rates in the Trail Mountain area (from Lines, 1985).

APPENDIX 7-6

EXCHANGE OF WATER RIGHTS

# APPENDIX 7-6

# EXCHANGE OF WATER RIGHTS

STATE OF UTAH
NATURAL RESOURCES
Water Rights

1[illegible]est North Temple • Suite 220 • Salt Lake City, UT 84116-3156 • 801-533-6071

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
Robert L. Morgan, State Engineer

March 7, 1986

Trail Mountain Coal Company
P.O. Box 550
Orangeville, UT 84537

Dear Applicant:

RE: APPROVED EXCHANGE APPLICATION
NUMBER 2402 (93-Area)

Enclosed is a copy of approved Exchange Application No. 2402 and the memorandum decision stating the conditions for approval. This is your authority under Section 73-3-20, Utah Code Annotated, as amended, to proceed with the construction work and use as approved.

This approval is effective only as long as you have a legal interest in the underlying water right used as a basis for the exchange and you are meeting the conditions established in approving the exchange. The Utah State Legislature has provided that the State Engineer may require the owner of record to provide such information as may be required to assure that the exchange is taking place as described. Failure to respond to such a request may result in lapsing of this application. Therefore, it is necessary that the Division of Water Rights be informed of any changes in ownership or address.

Sincerely,

Robert L. Morgan

Robert L. Morgan, P.E.
State Engineer

RLM:laz

Encl.: Copy of Approved Application
Memorandum Decision

BEFORE THE STATE ENGINEER OF THE STATE OF UTAH

IN THE MATTER OF EXCHANGE APPLICATION )
) MEMORANDUM DECISION
NUMBER E2402 (93-AREA) )

Exchange Application No. E2402 (93-AREA) was filed by Trail Mountain Coal Company of P.O. Box 550, Orangeville, Utah 84537 for the right to exchange 17.6 acre-feet of water represented by Stock Certificate #542 of the Cottonwood Creek Consolidated Irrigation Company, indicating the ownership of said company which has direct flow rights on Cottonwood Creek. Stock certificate #542 has been stamped non-transferable by the Cottonwood Creek Consolidated Irrigation Company. It is proposed that in lieu of diverting 17.6 acre-feet from Cottonwood Creek, that this same quantity of water be diverted from a 12-inch diameter well 300-350 feet deep located at a point North 3350 feet & East 1952 feet from the SW Corner, Section 25, T17S, R6E, SLB&M. The water will be used on an annual basis for the domestic requirements of 80 people, dust suppression and other industrial uses in conjunction with the Trail Mountain Coal Mine located within the E1/2 Section 25, T17S, R6E, SLB&M. If this Exchange Application is approved, it will supersede Exchange Application E2137, approved by the State Engineer on August 26, 1983. The application was advertised in the Emery County Progress from December 18, 1985, through January 1, 1986 and was not protested.

It is the opinion of the State Engineer that this exchange may be made providing the provisions of the Cottonwood Creek Exchange Policy of the Utah State Engineer as outlined herein are adhered to.

It is therefore ordered and Exchange Application E2402 (93-AREA) is hereby APPROVED subject to the following stipulations:

1. No more water may be diverted during the use period than is represented by the stock in the Cottonwood Creek Consolidated Irrigation Company, which is the basis for the exchange.

2. Installation of a totalizing meter at the expense of the applicant will be required before any water is diverted. Water meters shall be available to the Cottonwood Creek River Commissioner for examination at all reasonable times.

3. The water being exchanged shall be regulated by the Cottonwood Creek River Commissioner at the expense of the applicant.

4. Continued ownership of the stock certificate which is the basis for the exchange, shall be required in order to maintain this exchange.

5. No change of point of diversion or place of use of the water covered by this exchange shall be made without first obtaining the approval of the State Engineer.

This decision is subject to the provisions of Section 73-3-14, Utah Code Annotated, 1953, which provides for plenary review by the filing of a civil action in the appropriate district court within sixty days from the date hereof.

Dated this 7th day of March, 1986.

Robert L. Morgan

Robert L. Morgan, P.E., State Engineer

RLM:MP:laz

Mailed a copy of the foregoing Memorandum Decision this 7th day of March, 1986 to:

Trail Mountain Coal Company
P.O. Box 550
Orangeville, UT 84537

BY: Laurel A. Zundel

Laurel A. Zundel, Secretary

## STATE ENGINEER'S ENDORSEMENT

EXCHANGE APPLICATION NUMBER: E2402 WATER USER'S CLAIM NUMBER: 93 - AREA

1. October 11, 1985 Exchange Application received by MP.

2. October 11, 1985 Priority of Exchange Application.

3. October 16, 1985 Application reviewed and approved for advertising by MP.
   December 18, 1985 Publication began in Emery County Progress.
   February 5, 1986 Publication completed and verified by DL.

4. January 31, 1986 End of protest period.
   Application protested: NO

5. February 11, 1986 Application designated for APPROVAL by MP and SG.

6. Comments:

Conditions:
This application is hereby APPROVED by Memorandum Decision, dated March 7, 1986, subject to prior rights.

Robert L. Morgan

Robert L. Morgan, P.E.
State Engineer

# APPLICATION FOR EXCHANGE OF WATER

## STATE OF UTAH

*Rec. by* _____
*Fee Paid $* _____
*Receipt #* _____
*Microfilmed* _____
*Roll #* _____

**For the purpose of obtaining permission to make an exchange of water in the State of Utah, application is hereby made to the State Engineer, based upon the following showing of facts, submitted in accordance with the requirements of the Laws of Utah. (Sec. 73-3-20, Utah Code Annotated, 1953)**

EXCHANGE: E2402 (93-AREA) Priority Date: 10/11/1985

1. NAME: Trail Mountain Coal Company PHONE #: 801-748-2140
ADDRESS: P.O. Box 550, Orangeville, UT 84537

**********CURRENT RIGHT**********

2. RIGHT EVIDENCED BY: Cottonwood Creek Irrigation Co. Cert. No. 542

3. FLOW: 17.6 acre-feet
SOURCE: Cottonwood Creek TRIBUTARY: San Rafael River
COUNTY: Emery

5. NATURE OF USE: PERIOD OF USE:
OTHER: Irrigation purposes on Cottonwood Creek. Jan 1 to Dec 31

**********PROPOSED EXCHANGE**********

6. FLOW: 17.6 acre-feet PERIOD OF USE: Jan 1 to Dec 31
SOURCE: Underground water well
COUNTY: Emery COMMON DESCRIPTION: 8 mi. NW of Orangeville

7. POINT OF EXCHANGE -- UNDERGROUND:
(1) N 3350 ft. E 1952 ft. from SW corner, Section 25, T 17S, R 6E, SLBM
Diameter of Well: 12 Ins. Depth: 300 to 350 ft.

8. POINT(S) OF RELEASE:
FLOW: 17.6 acre-feet PERIOD OF USE: Mar 1 to Nov 30

9. NATURE OF USE: PERIOD OF USE:
DOMESTIC: 80 Persons Jan 1 to Dec 31
INDUSTRIAL: Minig related, dust suppression Jan 1 to Dec 31

PLACE OF USE:

Sec 25 T 17S R 6E SLBM

| NORTH-EAST ¼ | | NORTH-WEST ¼ | | SOUTH-WEST ¼ | | SOUTH-EAST |
|---|---|---|---|---|---|---|
| NE NW SW SE | | NE NW SW SE | | NE NW SW SE | | NE NW SW SE |
| X: X: X: X | | : : : | | : : : | | X: X: X: |

Continued on Next Page

Exchange

EXPLANATORY

This Exchange Application, if approved will replace Exchange Application No. 2137, approved August 26, 1983.
Water currently diverted at Cottonwood Creek Irrigation Company diversion points. Water used on Cottonwood Creek Irrigation Company lands.

**********

If applicant is a corporation or other organization, signature must be the name of such corporation or organization by its proper officer, or in the name of the partnership by one of the partners, and the names of the other partners shall be listed. If there is more than one applicant, a power of attorney, authorizing one to act for all should accompany the application.

**********

The undersigned hereby acknowledges that even though he/she may have been assisted in the preparation of the above-numbered application through the courtesy of the employees of the State Engineer's Office, all responsibility for the accuracy of the information contained therein, at the time of filing, rests with the applicant(s).

_____

Signature of Applicant

FORM 10E

Exchange Application No. 2139

93-Area

# APPLICATION FOR THE RIGHT OF EXCHANGE OF WATER

## STATE OF UTAH

SEP 28 19[illegible]

RECEIVED

SEP 0 8 [illegible]

[illegible]

For the purpose of obtaining permission to make an exchange of water, application is hereby made to State Engineer, based upon the following showing of facts submitted in accordance with the requirements of Sec. 73-3-20, Utah Code Annotated, 1953.

1. The name of the applicant is Natomas Trail Mountain Coal Co.
2. The post office address of the applicant is P.O. Box 551 Orangeville, Utah 84537
3. The right to be exchanged was acquired by Cottonwood Creek Consolidated Irrigation Company Certificate No. 542
   *(Give application No., certificate No., Decree, stock purchase, or other identification.)*
4. The quantity of water is _____ second-feet, or 17.6 acre-feet.
5. The period of use from March (Month) 1 (Day) to November (Month) 30 (Day), inc.
6. The period of storage from _____ (Month) _____ (Day) to _____ (Month) _____ (Day), inc.
7. The direct source of supply is Cottonwood Creek tributary to _____ in Emery county.
8. The point of diversion is* various point on Cottonwood Creek as established by decrees, HUC, etc.
9. The water is, or was, to be used for the following purposes: irrigation purposes on Cottonwood Creek. (as per mark [illegible]) _____ Total _____ acres.
   *(Give place of use by legal subdivision of land)*

**THE FOLLOWING EXCHANGE IS PROPOSED**

10. _____ second-feet or 17.6 acre-feet of water represented by the foregoing right will be delivered from March (Month) 1 (Day) to November (Month) 30 (Day) incl. of each year, to satisfy other rights, into _____ at a point* various points of diversion on Cottonwood Creek
11. In exchange for the water delivered and described in par. 10, there will be _____ second-feet or 17.6 acre-feet diverted from January (Month) 1 (Day) to December (Month) 31 (Day) incl., of each year from a well _____ (diameter and depth) or stream Cottonwood Creek, at a point* N. 600 ft. & W. 1950 ft. from the E¼ Cor. Sec. 25, T17S, R6E, SLB&M. (8 miles NW of Orangeville)
12. The water will be used for Industrial purposes, dust suppression, culinary water for 80 people at the Natomas Trail Mountain Coal Mine. (E¼ Sec. 25, T17S, R6E, SLB&M). _____ Total _____ acres.

NOTE: *The point of diversion, point of return or point of delivery must be located by course and distance or by rectangular distances with reference to some United States land survey corner.*

## EXPLANATORY

The following additional facts are set forth in order to define more clearly the full purpose of the proposed application:

Year Round Use - Industrial Uses at a Coal Mine

Signature of Applicant*

*If applicant is a corporation or other organization, signature must be the name of such corporation or organization by its proper officer, or in the name of the partnership by one of the partners, and the names of the other partners shall be listed. If there is more than one applicant, a power of attorney, authorizing one to act for all should accompany the application.

This section is not to be filled in by applicant

## STATE ENGINEER'S ENDORSEMENTS

1. 11-28-82 Application received by mail / over counter in State Engineer's office by
2. Priority of Application brought down to, on account of
3. 12-1-82 Application fee, $ 150.00, received by [illegible] Rec. No. [illegible]
4. 12-2-82 Application microfilmed by [illegible], indexed by [illegible]
5. Application platted by
6. 12-5-82 Application examined by LO
7. Application returned , or corrected by office
8. Corrected Application resubmitted by mail / over counter to State Engineer's Office.
9. 12-7-82 Application approved for advertisement by LO
10. DEC 2 - 82 Notice to water users prepared by WHJ
11. DEC. [illegible] 82 Publication began: was completed JAN - [illegible]
    Notice published in Emery Co. Progress
12. Proof slips checked by
13. 1-13-83 Application protested by U.S. Fish & Wildlife
14. 1/28/83 Publisher paid by M.E.V. No. C31206
15. Hearing held by
16. Field examination by
17. 7/1/83 Application designated for approval SG & MP
18. 8/26/83 Application microfilmed and/or photostated by slm
19. 8/26/83 Application approved / ~~xxxxxx~~

*THIS APPLICATION IS APPROVED ON THE FOLLOWING CONDITIONS:*

By Memorandum Decision dated August 26, 1983.

Earl M. Staker
FOR Dee C. Hansen, P.E., State Engineer

Exchange Application No. 2132

93-Area

APPENDIX 7-7

WELL APPROVAL

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

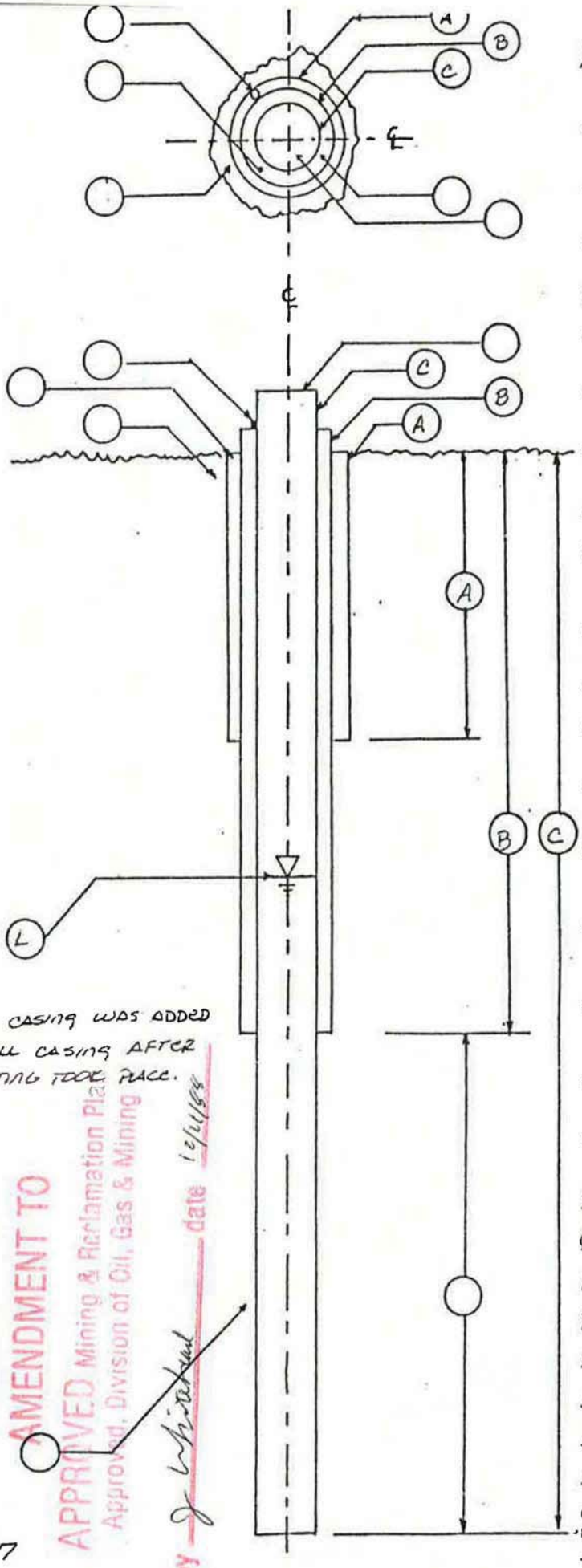
The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

APPENDIX 7-7

WELL APPROVAL




WELL FOR:

TRAIL MTN. MINE - BEAVER CREEK COAL
Name/Owner

EX 2402 (93-AREA)
Authorization to drill #

DAVES DRILLING
Driller

RICK WILDE - MARK PAGE 9-23-87
Observed by Date

ITEM DESCRIPTIONS:

A: 16" diameter casing (surface) 2' deep.

B: 12" diameter casing 115' deep.

C: 6" diameter production casing 460' deep.

D: Welded caps.

E: Annular space around surface casing cemented in. observed/(unobserved)

F: ____" diameter treamie grout line placed to ____'.

G: Access port ____" to ____'.

H: Calculated volume to fill annulus 92.4. Actual volume placed ____.

I: Total depth of completed well casing 460'. Borehole 500'.

J: Well screen from ____ to ____.
Type of screen ____.
Slot size ____.

J': Perforated area from 380' to 460'. Size ____ x ____.
# per round ____.

K: Volume of gravel pack placed around screen ____.
Naturally developed area.

L: Static water level 24.94'.
Flowing at surface ____.

M: Top 100' of strata ____

DESCRIPTION OF GROUT MATERIALS USED:

COLTON CEMENT TYPE I/II
PORTLAND CEMENT - LOW ALKALI
BENTONITE 5150 MUDDOCK - MILORGANITE

PLACEMENT METHOD: PUMPED DOWN THE PRODUCTION CASING AND UP INTO THE ANNULAR SPACE TO WITHIN 5'6" OF THE SURFACE

CERTIFIED AS MEETING PUBLIC SUPPLY SURFACE SEAL CRITERIA

X YES ____ NO

Mark L. Page 12-3-87
BY DATE

* 8 feet of casing was added to the well casing after the grouting took place.

AMENDMENT TO APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by [signature] date 12/11/87

App. 7-7
2/1/88

FORM 166

Exchange Application No. 2402

93-Area

# APPLICATION FOR THE RIGHT OF EXCHANGE OF WATER STATE OF UTAH

For the purpose of obtaining permission to make an exchange of water, application is hereby made to State Engineer, based upon the following showing of facts submitted in accordance with the requirements of Sec. 73-3-20, Utah Code Annotated, 1953.

1. The name of the applicant is Trail Mountain Coal Company
2. The post office address of the applicant is P.O. Box 550 Orangeville, Utah 84537
3. The right to be exchanged was acquired by Cottonwood Creek Irr. Co. Certificate No. 542
   *(Give application No., certificate No., Decree, stock purchase, or other identification.)*
4. The quantity of water is _____ second-feet, or 17.6 acre-feet.
5. The period of use from March 1 *(Month)* *(Day)* to November 30 *(Month)* *(Day)*, inc.
6. The period of storage from _____ *(Month)* *(Day)* to _____ *(Month)* *(Day)*, inc.
7. The direct source of supply is Cottonwood Creek tributary to _____ in Emery county.
8. The point of diversion is* various points on Cottonwood Creek as established by decrees, WUC, etc.
9. The water is, or was, to be used for the following purposes: Irrigation purposes on Cottonwood Creek.

   _____ Total _____ acres.
   *(Give place of use by legal subdivision of land)*

## THE FOLLOWING EXCHANGE IS PROPOSED

10. _____ second-feet or 17.6 acre-feet of water represented by the foregoing right will be delivered from March 1 *(Month)* *(Day)* to November 30 *(Month)* *(Day)* incl. of each year, to satisfy other rights, into _____ at a point* various points of diversion on Cottonwood Creek
11. In exchange for the water delivered and described in par. 10, there will be _____ second-feet or 17.6 acre-feet diverted from January 1 *(Month)* *(Day)* to December 31 *(Month)* *(Day)* incl., of each year from a well 12-inch diameter, 300-350 ft. *(diameter and depth)* or stream _____, at a point* N.3350 ft. & E. 1952 ft. from SW Cor. Sec. 25, T17S, R6E, SLB&M. (8 miles NW of Orangeville)
12. The water will be used for Industrial purposes, dust suppression, culinary water for 80 people at the Trail Mountain Coal Mine (E½ Sec. 25, T17S, R6E, SLB&M). This exchange application, if approved will replace Exchange Application No. 2137, approved August 26, 1983. Total _____ acres.

NOTE: *The point of diversion, point of return or point of delivery must be located by course and distance or by rectangular distances with reference to some United States land survey corner.*

Num _____
appl _____

## EXPLANATORY

The following additional facts are set forth in order to define more clearly the full purpose of the proposed application:

Signature of Applicant*

*If applicant is a corporation or other organization, signature must be the name of such corporation or organization by its proper officer, or in the name of the partnership by one of the partners, and the names of the other partners shall be listed. If there is more than one applicant, a power of attorney, authorizing one to act for all should accompany the application.

This section is not to be filled in by applicant

## STATE ENGINEER'S ENDORSEMENTS

1. Oct. 11, 1985 — Application received (by mail / over counter) in State Engineer's office by [illegible]
2. ____ — Priority of Application brought down to, on account of ____
3. ____ — Application fee, $____, received by ____ Rec. No. ____
4. ____ — Application microfilmed by ____, indexed by ____
5. ____ — Application platted by ____
6. 10-16-85 — Application examined by [illegible]
7. ____ — Application returned ____, or corrected by office ____
8. ____ — Corrected Application resubmitted (by mail / over counter) to State Engineer's Office.
9. 10-16-85 — Application approved for advertisement by [illegible]
10. ____ — Notice to water users prepared by ____
11. Dec. 17, 1985 — Publication began; was completed Dec. 25 1985 & Jan. 1, 1986
    Notice published in Ewing County Enquirer
12. ____ — Proof slips checked by ____
13. ____ — Application protested by ____
14. ____ — Publisher paid by M.E.V. No. ____
15. ____ — Hearing held by ____
16. ____ — Field examination by ____
17. 2-11-86 — Application designated for (approval / rejection) [illegible]
18. ____ — Application microfilmed and/or photostated by ____
19. 3-1-86 — Application (approved / ~~rejected~~)

WATER RIGHTS DATA BASE
ENTERED - DATE 2/27/86 BY JJL
VERIFIED - DATE 2/27/86 BY JJL

*THIS APPLICATION IS APPROVED ON THE FOLLOWING CONDITIONS:*

State Engineer

Exchange Application No. 2402

43-414

MAR 13 1986

WATER RIGHTS
PRICE

BEFORE THE STATE ENGINEER OF THE STATE OF UTAH

IN THE MATTER OF EXCHANGE APPLICATION )
) MEMORANDUM DECISION
NUMBER E2402 (93-AREA) )

Exchange Application No. E2402 (93-AREA) was filed by Trail Mountain Coal Company of P.O. Box 550, Orangeville, Utah 84537 for the right to exchange 17.6 acre-feet of water represented by Stock Certificate #542 of the Cottonwood Creek Consolidated Irrigation Company, indicating the ownership of said company which has direct flow rights on Cottonwood Creek. Stock certificate #542 has been stamped non-transferable by the Cottonwood Creek Consolidated Irrigation Company. It is proposed that in lieu of diverting 17.6 acre-feet from Cottonwood Creek, that this same quantity of water be diverted from a 12-inch diameter well 300-350 feet deep located at a point North 3350 feet & East 1952 feet from the SW Corner, Section 25, T17S, R6E, SLB&M. The water will be used on an annual basis for the domestic requirements of 80 people, dust suppression and other industrial uses in conjunction with the Trail Mountain Coal Mine located within the E1/2 Section 25, T17S, R6E, SLB&M. If this Exchange Application is approved, it will supersede Exchange Application E2137, approved by the State Engineer on August 26, 1983. The application was advertised in the Emery County Progress from December 18, 1985, through January 1, 1986 and was not protested.

It is the opinion of the State Engineer that this exchange may be made providing the provisions of the Cottonwood Creek Exchange Policy of the Utah State Engineer as outlined herein are adhered to.

It is therefore ordered and Exchange Application E2402 (93-AREA) is hereby APPROVED subject to the following stipulations:

1. No more water may be diverted during the use period than is represented by the stock in the Cottonwood Creek Consolidated Irrigation Company, which is the basis for the exchange.

2. Installation of a totalizing meter at the expense of the applicant will be required before any water is diverted. Water meters shall be available to the Cottonwood Creek River Commissioner for examination at all reasonable times.

3. The water being exchanged shall be regulated by the Cottonwood Creek River Commissioner at the expense of the applicant.

4. Continued ownership of the stock certificate which is the basis for the exchange, shall be required in order to maintain this exchange.

5. No change of point of diversion or place of use of the water covered by this exchange shall be made without first obtaining the approval of the State Engineer.

This decision is subject to the provisions of Section 73-3-14, Utah Code Annotated, 1953, which provides for plenary review by the filing of a civil action in the appropriate district court within sixty days from the date hereof.

Dated this 7th day of March, 1986.

Robert L. Morgan

Robert L. Morgan, P.E., State Engineer

RLM:MP:laz

Mailed a copy of the foregoing Memorandum Decision this 7th day of March, 1986 to:

Trail Mountain Coal Company
P.O. Box 550
Orangeville, UT 84537

BY: Laurel A. Zundel

Laurel A. Zundel, Secretary

COTTONWOOD CREEK CONSOLIDATED

IRRIGATION COMPANY

Orangeville, Utah 84537

January 8, 1982

Natomas Trail Mountain Coal Co.
Box 551
Orangeville, Utah 84537

Attn: Andrew King

Dear Sir;

The records of the Cottonwood Creek Consolidated Irrigation Company have Trail Mountain Coal Company as owning 20 shares of the primary stock of the Irrigation Company. The yield of this stock on an average year would be .88 of an acre foot of water per share. However, this is an average which was established before the Joe's Valley Dam was built and since that time it is a rare year that the yield is below 1.00 acre foot per share.

Respectfully,

John L. Jorgensen

John L. Jorgensen
Secretary.

1982 JAN
RECEIVED
Natomas Trail
Mountain Coal

RECEIVED
OCT 24 1985
WATER RIGHTS

**Diamond Shamrock**
Coal Company

October 22, 1985

Mark Page
State Engineer
Division of Water Rights
P. O. Box 718
Price, Utah 84501

RE: Drilling of an Observation Well at Trail Mountain Mine Site

Dear Mark;

I am writing at this time, to request of you and the State Engineer, approval to drill an observation well at a location within the following legal description:

> The following described land situated in Emery County, State of Utah; beginning at the southwest corner of the northwest quarter of the southeast quarter of Section 25, Township 17 south, Range 6 east, SLB&M, thence north 160 rods; thence east 44 rods, more or less to the center line of Cottonwood Creek, thence in a southerly direction along the center line of said Cottonwood Creek to a point 76 rods, more or less, east of beginning; thence west 76 rods, more or less, to the point of beginning.

The above legal description is on fee property owned by the Trail Mountain Coal Company. (see enclosure)

The primary objectives of this observation well and others by the United States Geological Survey and the Division of Oil, Gas and Mining are to determine aquifer characteristics, hydraulic connection between aquifers and with streams, recharge and discharge relationships and the effects of underground mining on the ground water system.

The above mentioned well will have a total depth of approximately 300 feet. The top 60 feet will be 9 7/8 inch diameter and will be cased with 8 7/8 inch metal casing and will have a concrete grouted seal. Under the casing will be a 7 7/8 inch diameter hole for a depth of approximately 240 feet.

**Trail Mountain Coal Company** A Subsidiary of Diamond Shamrock
P.O. Box 370 Orangeville Utah 84537-0370 Phone: 801 748-2140

This well will be drilled by Mr. Alan Tracy, who is a licenced driller with experience in this area. This well will be drilled pursuant to section 13 of the State of Utah regulations for water well drillers.

Because of weather and budgeting constraints, we would desire to drill this well as soon as possible. Your response and consideration in this matter is greatly appreciated.

Should you need additional information or have further questions, please feel free to contact me at 748-2140.

Sincerely;

TRAIL MOUNTAIN COAL COMPANY

Allen Childs

Allen P. Childs
Engineer

APC/gg

At the request of this office, Allen Childs called on October 30, 1985 with the following information:

The location of the test well is:
N. 3350 ft. & E. 1952 ft. from the SW Cor. Sec. 25, T17S, R6E, SLB&M.

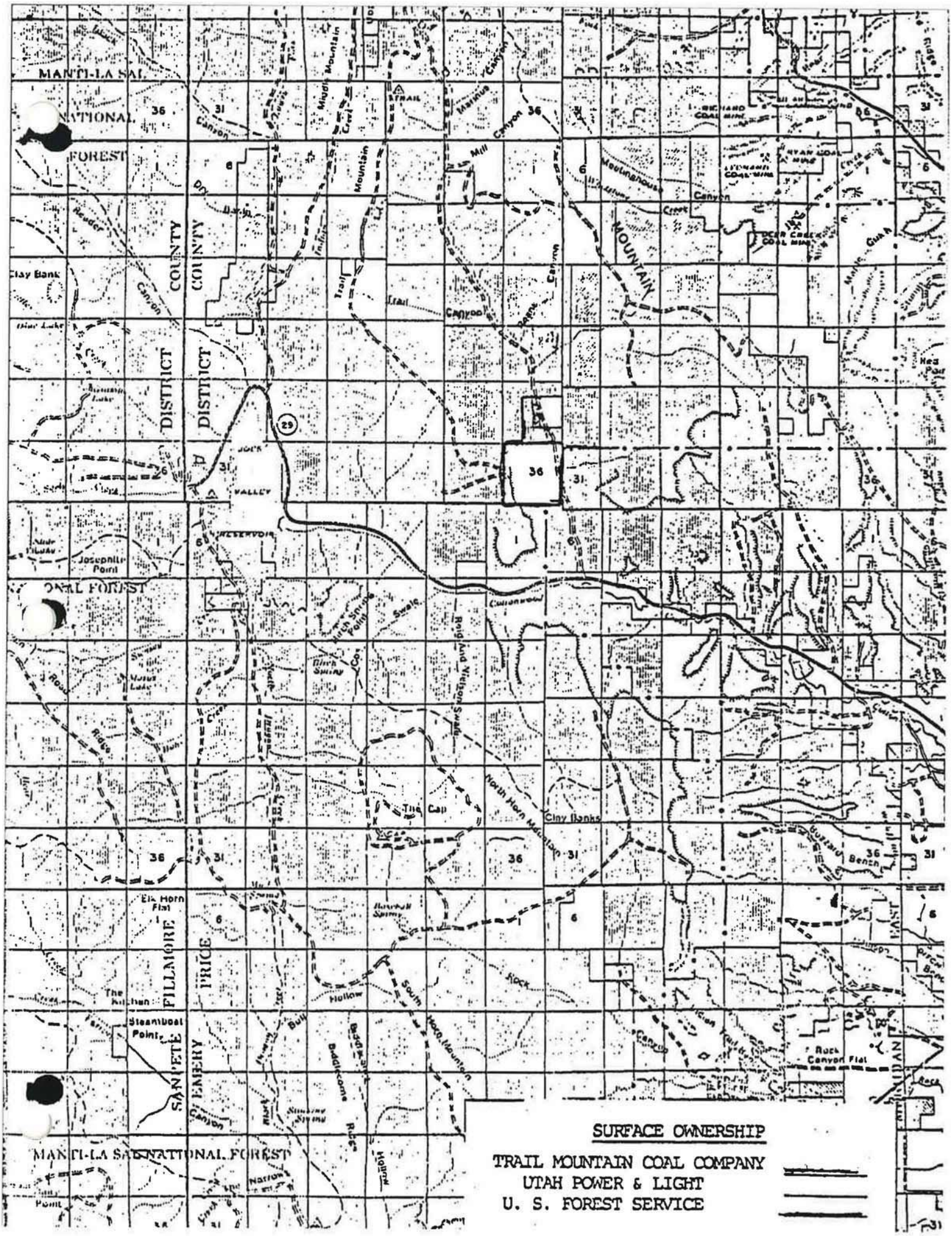
Mark Page

ATTN: Kent Jones

The applicant has an exchange application in process to cover this test hole if it is productive. They are using Alan Tracy to drill the well. He is on site doing some coal work. I feel like we should approve this request.

If you have any questions give me a call

Thanks Mark


SURFACE OWNERSHIP
TRAIL MOUNTAIN COAL COMPANY
UTAH POWER & LIGHT
U. S. FOREST SERVICE

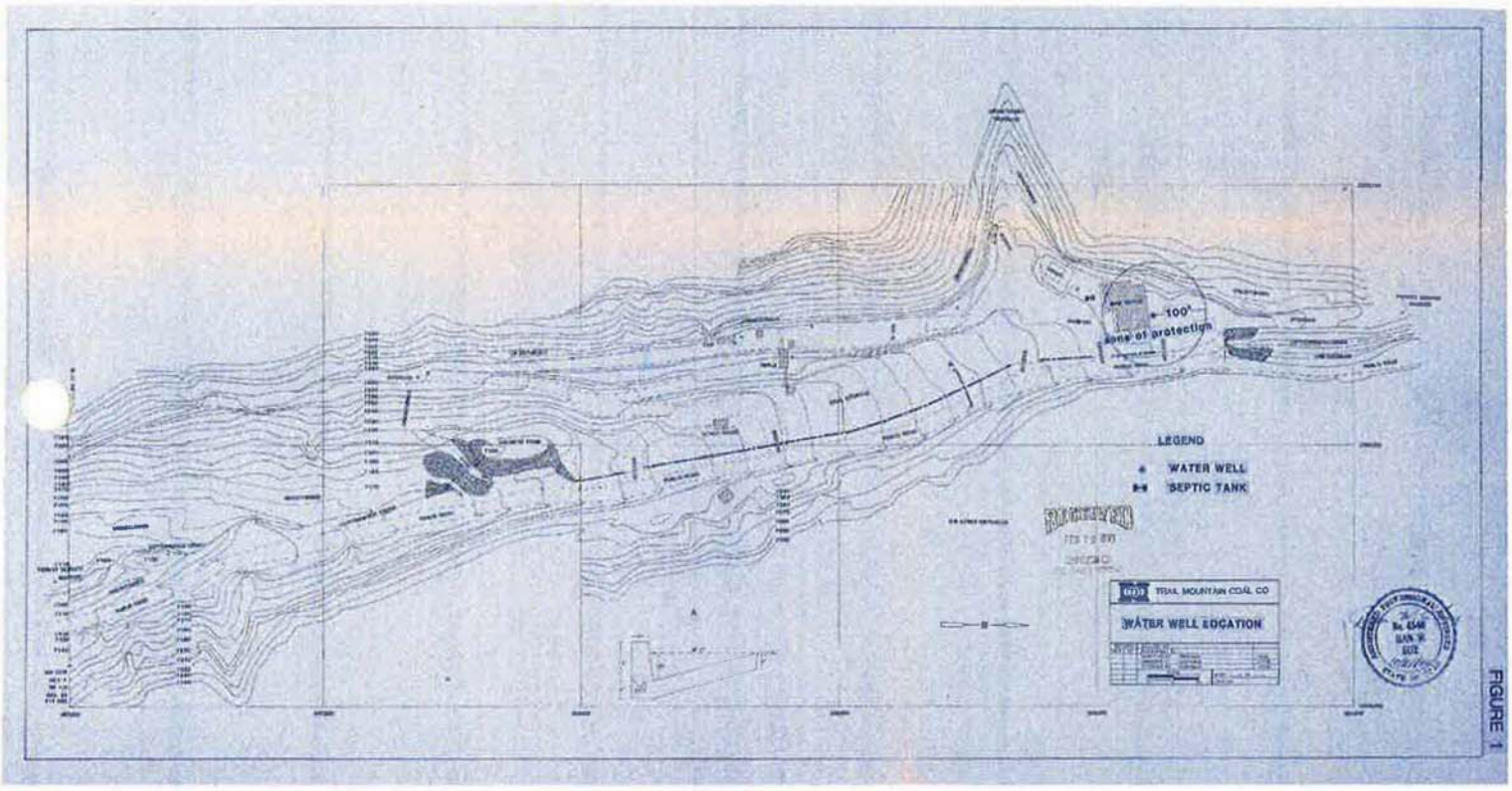

100'
zone of protection
LEGEND
WATER WELL
SEPTIC TANK
TRAIL MOUNTAIN COAL CO
WATER WELL EDCATION

FIGURE 1

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

APPENDIX 7-8

WATER SHARES

# APPENDIX 7-8

# COTTONWOOD CREEK IRRIGATION SHARES

L

COTTONWOOD CREEK CONSOLIDATED

IRRIGATION COMPANY

Orangeville, Utah 84537

January 8, 1982

Natomas Trail Mountain Coal Co.
Box 551
Orangeville, Utah 84537

Attn: Andrew King

Dear Sir;

The records of the Cottonwood Creek Consolidated Irrigation Company have Trail Mountain Coal Company as owning 20 shares of the primary stock of the Irrigation Company. The yield of this stock on an average year would be .88 of an acre foot of water per share. However, this is an average which was established before the Joe's Valley Dam was built and since that time it is a rare year that the yield is below 1.00 acre foot per share.

Respectfully,

John L. Jorgensen
Secretary.

APPEDNIX 7-9

SPRING INVENTORIES – 1981/1985

# APPENDIX 7-9

# SPRING INVENTORIES

# 1981 / 1985

SPRING INVENTORY (1981)

SPRING INVENTORY (1985)

STANDARD LABORATORIES, INC.
P. O. Box 1140, Huntington, UT 84528 801-653-2314

November 23, 1983

Mr. Allen Childs
Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Dear Allen:

As per your request and instructions, Standard laboratories sampled various water sites (SW-1, SW-2, SW-3, UG-1, TM21-1, TM22-1, TM23-1 and in-mine pond) on November 4, 1983. It is understood and agreed that Standard will continue to sample SW-1, SW-2, SW-3 and UG-1 on a monthly basis as flow permits. We will sample TM21-1, Tm22-1 and TM23-1 twice annually. In addition to performing the analytical tests necessary to determine water qualtiy at each of these locations, Standard will measure the quantity of water flowing at each site (TM21-1, TM22-1, TM23-1 and of the Cottonwood Creek).

Per your request, I returned to the aforementioned sites on November 16, 1983 for the purpose of determining flow quantity. Following is a listing of the measurements taken:

| | |
|---|---|
| Cottonwood Creek | 7.6 cu ft/sec. |
| UG-1 | $1.7 \times 10^{-4}$ cu ft/sec. |
| TM21-1 | 0.3 cu ft/sec |
| TM22-1 | Inaccessible due to snow |
| TM23-1 | Inaccessible due to snow |

Sincerely,

Ray A. Sim
Laboratory Manager

CERTIFICATE OF ANALYSIS

# STANDARD LABORATORIES, INC.

P.O. Box 1140, Huntington, Utah 84528 801-653-2314

Lab. No. 3898

Client: Trail Mountain Coal Co.
P. O. Box 370
Orangeville, Utah 84537

Sample ID: Spring
TM 21-1

Date Rec'd 5-4-83

Date Sampled 4-29-83

Time Sampled _____

| | | | |
|---|---|---|---|
| Acidity | _____ mg/l $CaCO_3$ | Aluminum | _____ mg/l |
| Alkalinity, Total | _____ mg/l $CaCO_3$ | Arsenic | _____ mg/l |
| Alkalinity, Bicarbonate | _____ mg/l $CaCO_3$ | Barium | _____ mg/l |
| Alkalinity, Carbonate | _____ mg/l $CaCO_3$ | Beryllium | _____ mg/l |
| Chloride | _____ mg/l | Boron | _____ mg/l |
| Coliform, Fecal | _____ MPN/100 ml | Cadmium | _____ mg/l |
| Coliform, Total | _____ MPN/100 ml | Calcium | _____ mg/l |
| Conductivity | _____ umhos/cm | Chromium | _____ mg/l |
| Fluoride | _____ mg/l | Copper | _____ mg/l |
| Hardness, Total | _____ mg/l $CaCO_3$ | Iron | _____ mg/l |
| Nitrogen, Ammonia | _____ mg/l | Lead | _____ mg/l |
| Nitrogen, Nitrate | _____ mg/l | Magnesium | _____ mg/l |
| Nitrogen, Nitrite | _____ mg/l | Manganese | _____ mg/l |
| Oil & Grease | _____ mg/l | Mercury | _____ ug/l |
| pH | _____ Units | Nickel | _____ mg/l |
| Phosphorus, Ortho | _____ mg/l | Potassium | _____ mg/l |
| Phosphorus, Total | _____ mg/l | Selenium | _____ mg/l |
| Solids, Total Dissolved | 400 mg/l | Silica | _____ mg/l |
| Solids, Total Suspended | < 0.5 mg/l | Sodium | _____ mg/l |
| Sulfate | _____ mg/l | Vanadium | _____ mg/l |
| Sulfide | _____ mg/l | Zinc | _____ mg/l |
| Turbidity | _____ NTU | | |

Respectfully submitted Ray Lee

*Certified Environmental Laboratory*

CERTIFICATE OF ANALYSIS

# STANDARD LABORATORIES, INC.

P.O. Box 1140, Huntington, Utah 84528 801-653-2314

Lab. No. 4703

Client: Trail Mountain Coal Co. Sample ID: TM 23-1
P. O. Box 370
Orangeville, Utah 84537

Date Rec'd 11-4-83

Date Sampled 11-4-83

Time Sampled

| | | | |
|---|---|---|---|
| Acidity | < 1.0 mg/l $CaCO_3$ | Aluminum | < 0.05 mg/l |
| Alkalinity, Total | 240 mg/l $CaCO_3$ | Arsenic | < 0.001 mg/l |
| Alkalinity, Bicarbonate | 224 mg/l $CaCO_3$ | Barium | < 0.1 mg/l |
| Alkalinity, Carbonate | 16 mg/l $CaCO_3$ | Beryllium | mg/l |
| Chloride | 10 mg/l | Boron | 0.17 mg/l |
| Coliform, Fecal | MPN/100 ml | Cadmium | 0.015 mg/l |
| Coliform, Total | MPN/100 ml | Calcium | 54 mg/l |
| Conductivity | 610 umhos/cm | Chromium | < 0.05 mg/l |
| Fluoride | 0.16 mg/l | Copper | < 0.02 mg/l |
| Hardness, Total | mg/l $CaCO_3$ | Iron | 0.06 mg/l |
| Nitrogen, Ammonia | mg/l | Lead | < 0.05 mg/l |
| Nitrogen, Nitrate | mg/l | Magnesium | 42 mg/l |
| Nitrogen, Nitrite | mg/l | Manganese | < 0.01 mg/l |
| Oil & Grease | 3.0 mg/l | Mercury | < 0.2 ug/l |
| pH | 8.4 Units | Nickel | < 0.04 mg/l |
| Phosphorus, Ortho | < 0.01 mg/l | Potassium | 1 mg/l |
| Phosphorus, Total | < 0.01 mg/l | Selenium | 0.004 mg/l |
| Solids, Total Dissolved | 326 mg/l | Silica | mg/l |
| Solids, Total Suspended | < 0.5 mg/l | Sodium | 17 mg/l |
| Sulfate | 110 mg/l | Vanadium | < 0.2 mg/l |
| Sulfide | mg/l | Zinc | 0.009 mg/l |
| Turbidity | 2.5 NTU | | |
| Cation, Total | 6.88 meq/l | | |
| Anion, Total | 7.38 meq/l | | |

Respectfully submitted

*Certified Environmental Laboratory*

CERTIFICATE OF ANALYSIS

# STANDARD LABORATORIES, INC.

P.O. Box 1140, Huntington, Utah 84528 801-653-2314

Lab. No. 4702

Client: Trail Mountain Coal Co. Sample ID: TM 22-1
P. O. Box 370
Orangeville, Utah 84537

Date Rec'd 11-4-83

Date Sampled 11-4-83

Time Sampled

| | | | | | |
|---|---|---|---|---|---|
| Acidity | < 1.0 | mg/l $CaCO_3$ | Aluminum | 1.04 | mg/l |
| Alkalinity, Total | 590 | mg/l $CaCO_3$ | Arsenic | < 0.001 | mg/l |
| Alkalinity, Bicaroonate | 538 | mg/l $CaCO_3$ | Barium | < 0.1 | mg/l |
| Alkalinity, Carbonate | 52 | mg/l $CaCO_3$ | Beryllium | | mg/l |
| Chloride | 139 | mg/l | Boron | 0.34 | mg/l |
| Coliform, Fecal | | MPN/100 ml | Cadmium | 0.050 | mg/l |
| Coliform, Total | | MPN/100 ml | Calcium | 32 | mg/l |
| Conductivity | 1700 | umhos/cm | Chromium | < 0.05 | mg/l |
| Fluoride | 0.50 | mg/l | Copper | < 0.02 | mg/l |
| Hardness, Total | | mg/l $CaCO_3$ | Iron | 0.32 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | < 0.05 | mg/l |
| Nitrogen, Nitrate | | mg/l | Magnesium | 159 | mg/l |
| Nitrogen, Nitrite | | mg/l | Manganese | 0.09 | mg/l |
| Oil & Grease | 3.3 | mg/l | Mercury | < 0.2 | ug/l |
| pH | 8.6 | Units | Nickel | < 0.04 | mg/l |
| Phosphorus, Ortho | < 0.01 | mg/l | Potassium | 5 | mg/l |
| Phosphorus, Total | < 0.01 | mg/l | Selenium | 0.006 | mg/l |
| Solids, Total Dissolved | 852 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 153 | mg/l | Sodium | 87 | mg/l |
| Sulfate | 205 | mg/l | Vanadium | < 0.2 | mg/l |
| Sulfide | | mg/l | Zinc | < 0.005 | mg/l |
| Turbidity | 85.0 | NTU | | | |
| Cation, Total | 18.59 | meq/l | | | |
| Anion, Total | 20.00 | meq/l | | | |

Respectfully submitted

*Certified Environmental Laboratory*

CERTIFICATE OF ANALYSIS

# STANDARD LABORATORIES, INC.

P.O. Box 1140, Huntington, Utah 84528 801-653-2314

Lab. No. 4701
Date Rec'd 11-4-83
Date Sampled 11-4-83
Time Sampled

Client: Trail Mountain Coal Co.
P. O. Box 370
Orangeville, Utah 84537

Sample ID: TM 21-1

| | | | |
|---|---|---|---|
| Acidity | < 1.0 mg/l CaCO, | Aluminum | < 0.05 mg/l |
| Alkalinity, Total | 267 mg/l CaCO, | Arsenic | < 0.001 mg/l |
| Alkalinity, Bicarbonate | 267 mg/l CaCO, | Barium | < 0.1 mg/l |
| Alkalinity, Carbonate | < 1.0 mg/l CaCO, | Beryllium | mg/l |
| Chloride | 36 mg/l | Boron | 0.12 mg/l |
| Coliform, Fecal | MPN/100 ml | Cadmium | 0.019 mg/l |
| Coliform, Total | MPN/100 ml | Calcium | 34 mg/l |
| Conductivity | 875 umhos/cm | Chromium | < 0.05 mg/l |
| Fluoride | 0.21 mg/l | Copper | < 0.02 mg/l |
| Hardness, Total | mg/l CaCO, | Iron | 0.07 mg/l |
| Nitrogen, Ammonia | mg/l | Lead | < 0.05 mg/l |
| Nitrogen, Nitrate | mg/l | Magnesium | 53 mg/l |
| Nitrogen, Nitrite | mg/l | Manganese | < 0.01 mg/l |
| Oil & Grease | 4.2 mg/l | Mercury | < 0.2 ug/l |
| pH | 8.3 Units | Nickel | < 0.04 mg/l |
| Phosphorus, Ortho | < 0.01 mg/l | Potassium | 2 mg/l |
| Phosphorus, Total | < 0.01 mg/l | Selenium | 0.004 mg/l |
| Solids, Total Dissolved | 442 mg/l | Silica | mg/l |
| Solids, Total Suspended | 6 mg/l | Sodium | 58 mg/l |
| Sulfate | 115 mg/l | Vanadium | < 0.2 mg/l |
| Sulfide | mg/l | Zinc | 0.019 mg/l |
| Turbidity | 7.2 NTU | | |
| Cation, Total | 8.61 meq/l | | |
| Anion, Total | 8.75 meq/l | | |

Respectfully submitted

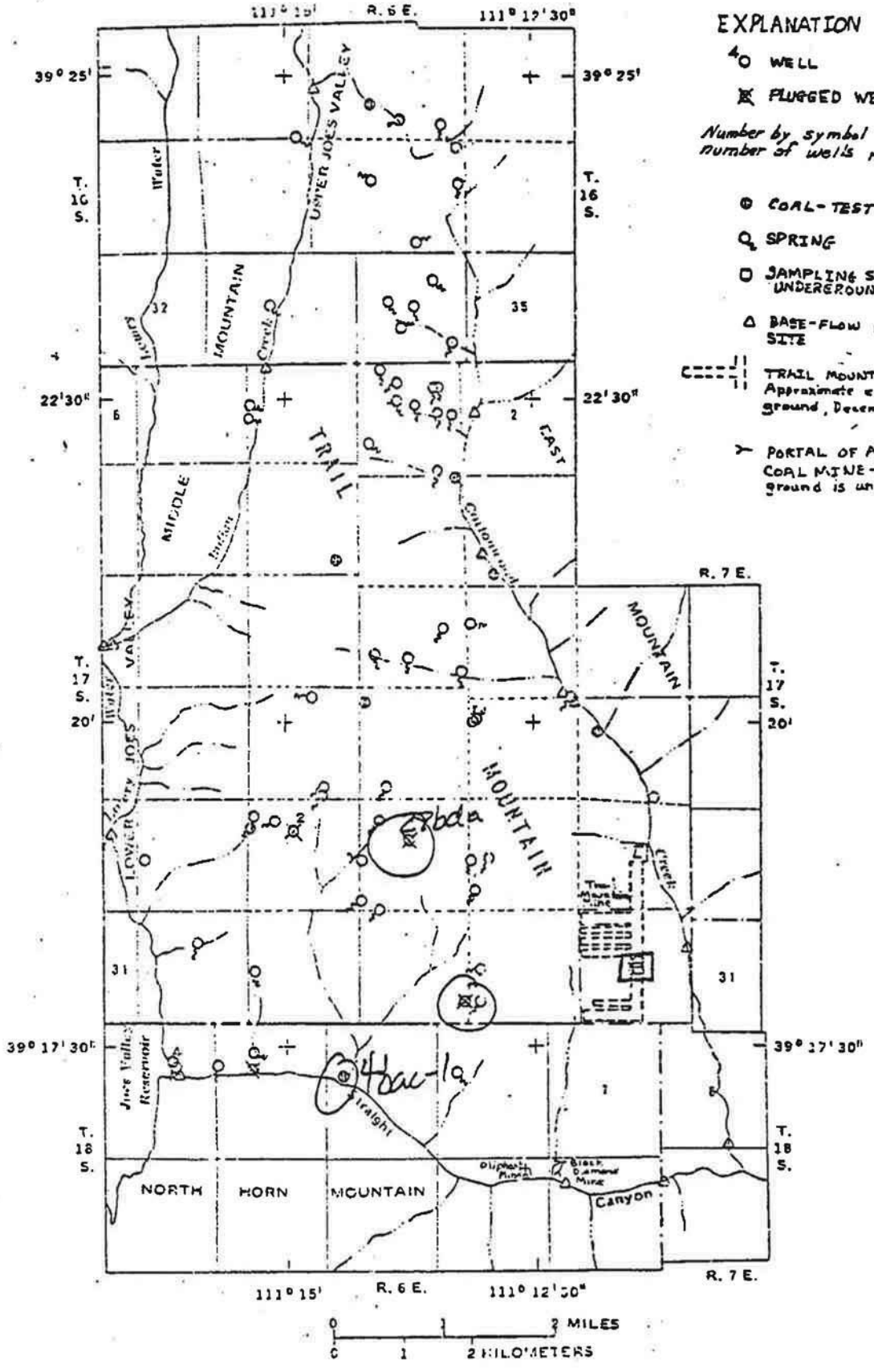



Figure 7. -- Data-collection sites and coal mines in the Trail Mountain area.

UNPUBLISHED REPORT
Subject to revision

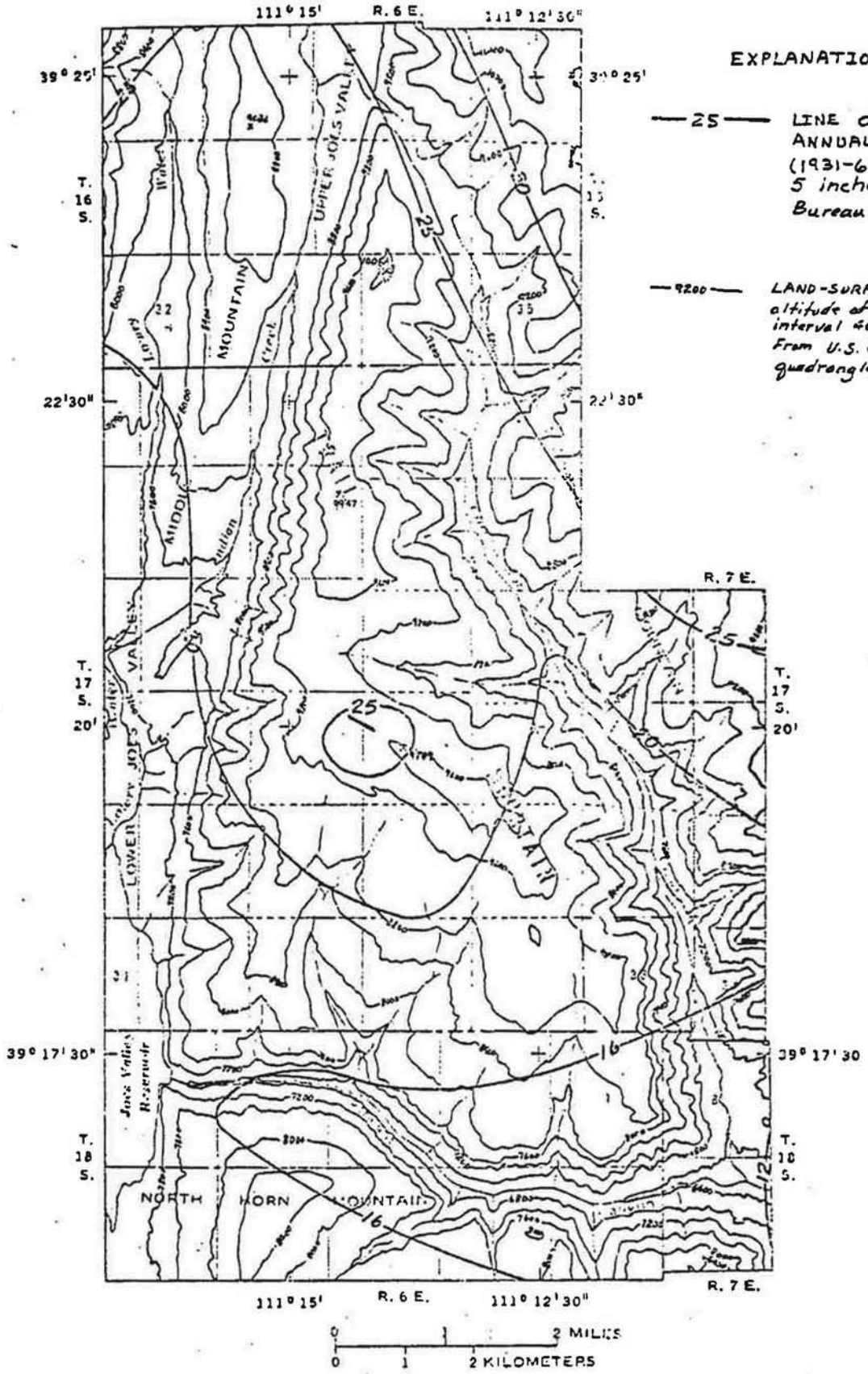



Figure 11.-- Normal annual precipitation and altitude of land surface.

Altitude of land surface: Interpolated from topographic

Casing: Depth--depth to top of perforations or first opening; P, depth to bottom of expandable packer in open hole.

Water-bearing zone(s): Ks, Star Point Sandstone; Kb, Blackhawk Formation; Ka, Castlegate Sandstone; Kp, Price River Formation; TKn, North Horn Formation; Qa, alluvium.

Use(s) of well: A, aquifer test; D, domestic supply; M, water-level monitoring.

Remarks and other data available: A, aquifer-test data in files of U.S. Geological Survey, Salt Lake City, Utah; C, chemical analysis in table 6; T, analysis of dissolved trace metals in table 7.

UNPUBLISHED REPORT
Subject to revision

| Well no. | Owner or user | Year completed | Altitude of land surface above sea level | Depth of well (feet) | Casing | | Water-bearing zone(s) | Water level above (+) or below land surface (feet) | Discharge (gallons per minute) | Date of water-level and discharge measurements | Use(s) of well | Remarks and other data available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Diameter (inches) | Depth (feet) | | | | | | |
| (D-17-6)24dcd-1 | Utah Power and Light Co. | 1978 | 7440 | 280 | 4 | 100 | Ks, Kb | 46 | 5.0 | 9-18-79 | M, A | A, C |
| 27bdu-1 | U.S. Geological Survey | 1982 | 9130 | 2500 | 4 | 1910P<br>2420P | Ks, Kb<br>Ks | 1484<br>1505 | 6.5<br>4.7 | 10-20-82<br>10-18-82 | A | First water at 130 feet in the North Horn Formation. 4-inch casing to 1400 feet, 3-inch casing to 1490 feet, and 3-inch open hole below. Plugged after testing. A, C |
| 28bad-1 | do. | 1982 | 8920 | 664 | 4 | 50<br>550 | TKn<br>TKn | 49<br>dry | .1<br>— | 10-28-82<br>10-25-82 | A | Casing perforated at 50-90 and 550-580 feet. Both perforated intervals tested with an expandable packer. Plugged after testing. |
| 28bad-2 | do. | 1982 | 8920 | 1220 | 4 | 1030 | Kp | 816 | 2.0 | 10-30-82 | A | Casing perforated at 1030-1080 feet. Plugged after testing. A, C |
| 29clb-1 | Jack World | 1982 | 7100 | 120 | 6 | 80 | Qa | 73 | — | 8-10-82 | D | C |
| 34dda-1 | U.S. Geological Survey | 1982 | 8760 | 1945 | 4 | 55<br>722<br>1446<br>1882 | TKn<br>Ks<br>Kb<br>Kb | 40<br>dry<br>1414<br>1478 | 1.5<br>—<br>.1<br>.2 | 9-23-82<br>9-25-82<br>10-6-82<br>10-9-82 | A | Casing perforated at 55-100, 722-742, 1446-1466, and 1882-1897 feet. Each perforated interval tested with an expandable packer. Plugged after testing. A |
| (D-18-6)4bac-1 | do. | 1981 | 6800 | 696 | 4 | 85 | Ks, Kb | +20 | 9.3 | 6-22-82 | A | First water reported at 45 feet in the Blackhawk Formation. Casing perforated at 85-410 feet and 3-inch open hole below. Plugged after testing. A, C |
| 5abd-1 | U.S. Bureau of Reclamation | 1980 | 7010 | 188 | 0.5 | 174 | Kb | 122 | — | 9-3-82 | M | Porous-tube piezometer |
| 5abd-2 | do. | 1980 | 7010 | 160 | 0.5 | 148 | Kb | 107 | — | 9-3-82 | M | Do. |
| 5abd-3 | do. | 1980 | 7010 | 154 | 0.5 | 135 | Kb | 67 | — | 9-3-82 | M | Do. |
| 5abd-4 | do. | 1980 | 7010 | 132 | 0.5 | 120 | Kb | 56 | — | 9-3-82 | M | Do. |

UNPUBLISHED REPORT
Subject to revision

| Spring no. | Altitude of land surface (feet above sea level) | Water-bearing zone | Date | Discharge (gallons per minute) | Specific conductance (micromhos) | Water temperature (°C) |
|---|---|---|---|---|---|---|
| (D-17-6) 15adc-S1 | 9080 | TKn | 6-27-79 | 1.6 | 490 | 7.0 |
| 15cad-S1 | 8840 | TKn | 7-5-79 | 1.0 | 560 | 8.5 |
| | | | 7-29-81 | 0.2 | 690 | 6.0 |
| 15cbd-S1 | 8950 | TKn | 7-13-79 | 1.2 | 680 | 13.5 |
| | | | 7-29-79 | dry. | - | - |
| 15dda-S1 | 8520 | Kp | 7-5-79 | 1.5 | 650 | 8.0 |
| 21abb-S1 | 9340 | TKn | 6-26-79 | .2 | 550 | 5.5 |
| | | | 7-14-81 | .6 | 630 | 7.5 |
| 21dcd-S1 | 9040 | TKn | 7-10-79 | 32 | 520 | 6.0 |
| | | | 7-14-81 | 12.4 | 560 | 7.0 |
| | | | 7-30-81 | 10.3 | 575 | 6.5 |
| | | | 8-20-81 | 7.6 | 600 | 7.0 |
| | | | 9-23-81 | 7.2 | 575 | 6.5 |
| | | | 5-21-82 | 44 | 570 | 6.5 |
| | | | 6-23-82 | 28 | 580 | 6.5 |
| | | | 7-15-82 | 20 | 580 | 6.0 |
| | | | 8-10-82 | 12.6 | 620 | 7.0 |
| | | | 9-2-82 | 13.5 | 600 | 7.0 |
| 21dcd-S2 | 9100 | TKn | 7-10-79 | 4.0 | 560 | 6.0 |
| 22cdc-S1 | 9220 | TKn | 7-14-81 | 5.0 | 495 | 8.0 |
| | | | 7-30-81 | 6.1 | 520 | 8.0 |
| | | | 8-20-81 | 5.3 | 535 | 6.0 |
| | | | 9-23-81 | 5.1 | 525 | 6.5 |
| | | | 5-21-82 | 40 | 520 | 6.5 |
| | | | 6-23-82 | 28 | 510 | 6.5 |
| | | | 7-15-82 | 23 | 520 | 6.0 |
| | | | 8-10-82 | 11.2 | 595 | 6.5 |
| | | | 9-2-82 | 12.4 | 510 | 7.0 |
| 23bcb-S1 | 8860 | TKn | 7-13-79 | 14 | 620 | 4.0 |
| 23bcb-S2 | 8780 | Kp | 7-13-79 | 24 | 630 | 4.5 |
| 26cba-S1 | 9200 | TKn | 6-27-79 | 6.. | 560 | 8.0 |
| | | | 7-14-81 | 1.1 | 600 | 11.0 |
| 26cbb-S1 | 9180 | TKn | 7-18-79 | 4.0 | 580 | 6.0 |
| | | | 7-14-81 | 1.3 | 640 | 7.5 |
| | | | 7-30-81 | 1.3 | 655 | 7.5 |
| | | | 8-20-81 | 1.1 | 720 | 7.0 |
| | | | 9-23-81 | 1.2 | 650 | 7.5 |
| | | | 5-21-82 | 5.0 | 660 | 7.0 |
| | | | 6-23-82 | 5.0 | 670 | 6.5 |
| | | | 7-15-82 | 4.8 | 660 | 6.0 |
| | | | 8-10-82 | 3.6 | 640 | 7.5 |
| | | | 9-2-82 | 2.6 | 660 | 7.5 |
| 26ccb-S1 | 8960 | TKn | 7-18-79 | 18 | 700 | 5.0 |
| 27bbd-S1 | 9050 | TKn | 8-16-79 | 4.0 | 500 | 6.5 |
| 27cbb-S1 | 8800 | TKn | 8-16-79 | 3.2 | 650 | 7.0 |
| | | | 7-15-81 | 2.3 | 680 | 7.0 |
| 27ccc-S1 | 8760 | TKn | 8-16-79 | 4.0 | 700 | 8.0 |
| | | | 7-15-81 | 1.7 | 665 | 7.5 |
| 27ccd-S1 | 8800 | TKn | 8-16-79 | 3.2 | 625 | 7.5 |
| | | | 7-15-81 | .6 | 710 | 8.5 |
| 28bac-S1 | 8800 | TKn | 7-16-81 | .8 | 740 | 10.0 |
| 28bbc-S1 | 8500 | TKn | 8-29-79 | 6.0 | 800 | 8.0 |
| 28bbc-S2 | 8340 | Kp | 8-29-79 | 6.0 | 540 | 9.0 |
| | | | 7-16-81 | .8 | 595 | 10.5 |
| 32acb-S1 | 7600 | Kp | 8-31-79 | - | 790 | - |
| 33cbb-S1 | 8400 | TKn | 8-30-79 | .1 | 950 | 12.0 |
| 35cbb-S1 | 8720 | TKn | 7-11-79 | .9 | 750 | 8.0 |
| | | | 7-15-81 | .2 | 780 | 12.0 |

| Spring no. | Altitude of land surface (feet above sea level) | Water-bearing zone | Date | Discharge (gallons per minute) | Specific conductance (micromhos) | Water temperature (°C) |
|---|---|---|---|---|---|---|
| (D-17-6) 35 ccb-S1 | 8720 | TKn | 7-12-79 | 5.1 | 560 | 6.5 |
| | | | 7-15-81 | 2.6 | 705 | 7.5 |
| | | | 7-30-81 | 2.5 | 740 | 7.0 |
| | | | 8-20-81 | 2.2 | 740 | 8.5 |
| | | | 9-23-81 | 2.6 | 725 | 8.0 |
| | | | 5-21-82 | 9.7 | 680 | 6.5 |
| | | | 6-23-82 | 6.4 | 690 | 7.5 |
| | | | 7-15-82 | 5.5 | 700 | 7.0 |
| | | | 8-10-82 | 5.0 | 690 | 7.5 |
| | | | 9-2-82 | 4.4 | 700 | 8.0 |
| (D-18-6) 2 bbd-S1 | 8120 | TKn | 7-12-79 | 0.5 | 940 | 8.0 |
| | | | 7-15-81 | .6 | 1140 | 9.0 |
| 4 bab-S1 | 7200 | Kc | 11-9-77 | 6.7 | 660 | 2.0 |
| 4 bbc-S1 | 7000 | Kb | 8-31-79 | 16 | 800 | 12.5 |
| | | | 7-13-81 | .6 | 870 | 17.0 |
| | | | 7-30-81 | 1.0 | 870 | 15.0 |
| | | | 8-20-81 | 11 | 920 | 15.0 |
| | | | 5-20-82 | .1 | 900 | 12.5 |
| | | | 6-23-82 | dry | – | – |
| 5 abd S1 | 6920 | Kb | 5-21-82 | 200 | 410 | 5.0 |
| | | | 10-28-82 | 180 | 425 | 5.0 |

UNPUBLISHED REPORT
Subject to revision

Attitude of land surface: Interpolated from topographic map.
Water-bearing zone: Kb, Blackhawk Formation; Kc, Castlegate Sandstone; Kp, Price River Formation; TKn, North Horn Formation.

UNPUBLISHED REPORT
Subject to revision

| Spring no. | Altitude of land surface (feet above sea level) | Water-bearing zone | Date | Discharge (gallons per minute) | Specific conductance (micromhos) | Water temperature (°C) |
|---|---|---|---|---|---|---|
| (D-16-6)21ddd-S1 | 8570 | TKn | 6-22-79 | 9.4 | 650 | 6.0 |
| | | | 9-19-79 | 0.5 | — | 10.0 |
| 22cda-S1 | 8900 | Kb | 7-16-81 | 6.1 | 660 | 6.5 |
| | | | 7-29-81 | 5.0 | 690 | 6.0 |
| | | | 8-20-81 | 5.2 | 600 | 5.5 |
| | | | 9-23-81 | 4.8 | 560 | 6.0 |
| | | | 5-21-82 | 14.6 | 580 | 6.0 |
| | | | 6-23-82 | 13.7 | 600 | 6.5 |
| | | | 7-17-82 | 13.0 | 615 | 6.5 |
| | | | 8-10-82 | 10.4 | 600 | 6.5 |
| | | | 9-2-82 | 10.9 | 600 | 6.5 |
| 22ddb-S1 | 9400 | Kp | 6-28-79 | 3.8 | 540 | 5.5 |
| 27aaa-S1 | 9460 | Kp | 6-19-79 | 9.4 | 430 | 3.5 |
| 27add-S1 | 9180 | Kc | 6-20-79 | .6 | 420 | 6.0 |
| 27bcd-S1 | 9580 | Kp | 8-23-79 | .8 | 400 | 6.0 |
| 27dcc-S1 | 9480 | Kp | 8-1-79 | 4.8 | 510 | 4.5 |
| 33bcd-S1 | 8380 | TKn | 10-1-80 | 13.0 | 580 | 7.0 |
| 34abd-S1 | 9280 | Kp | 8-1-79 | .05 | 580 | 7.0 |
| 34acc-S1 | 9560 | TKn | 6-20-79 | 13.0 | 440 | 5.0 |
| 34bdc-S1 | 9700 | TKn | 6-20-79 | 17.1 | 470 | 5.0 |
| 34cad-S1 | 9400 | Kp | 9-6-78 | .5 | 565 | 8.5 |
| 34dda-S1 | 8760 | Kp | 8-1-79 | 3.2 | 560 | 7.5 |
| (D-17-6)3aac-S1 | 9360 | Kp | 7-19-79 | .8 | 560 | 7.5 |
| 3aac-S2 | 9360 | Kp | 7-19-79 | A | 500 | 8.0 |
| 3acb-S1 | 8960 | Kp | 6-21-79 | 60 | 530 | 6.0 |
| 3adc-S1 | 8960 | Kc | 10-14-77 | 26 | 540 | 7.0 |
| | | | 7-4-79 | 24 | 550 | 7.5 |
| 3add-S1 | 8760 | Kc | 7-4-79 | 7.1 | 550 | 7.5 |
| 3bab-S1 | 9640 | TKn | 6-20-79 | .15 | 490 | 7.0 |
| 3bad-S1 | 9440 | Kp | 7-19-79 | 1.3 | 490 | 6.5 |
| 3bda-S1 | 9040 | Kp | 6-21-79 | 50 | 520 | 6.0 |
| 3cbd-S1 | 9400 | TKn | 7-31-79 | .62 | 470 | 7.0 |
| 3ddc-S1 | 8700 | Kc | 7-4-79 | 13 | 560 | — |
| 4bcc-S1 | 8190 | TKn | 6-15-79 | 29 | 620 | 5.0 |
| 4cbb-S1 | 8200 | TKn | 6-15-79 | 147 | 600 | 5.0 |
| 14bcb-S1 | 9080 | TKn | 6-27-79 | .65 | 470 | — |
| | | | 7-14-81 | dry | — | — |
| 14ddd-S1 | 7770 | Kb | 7-14-81 | 80 | 650 | 8.5 |
| | | | 7-30-81 | 76 | 640 | 8.0 |
| | | | 8-20-81 | 73 | 640 | 8.0 |
| | | | 9-24-81 | 76 | 660 | 8.0 |
| | | | 5-20-82 | 80 | — | — |
| | | | 6-23-82 | 76 | 670 | 8.0 |
| | | | 7-17-82 | 98 | 670 | 7.5 |
| | | | 8-10-82 | 98 | 660 | 8.5 |
| | | | 9-8-82 | 110 | 600 | 8.5 |

Water-bearing zone(s): Ks, Star Point Sandstone; Kb, Blackhawk Formation; Kc, Castlegate Sandstone; Kp, Price River Formation; TKn, North Horn Formation; Qa, alluvium.

UNPUBLISHED REPORT
Subject to revision

| Well, spring, or site no. | Date of collection | Water-bearing zone(s) | Water temperature (°C) | pH (units) | Specific conductance (micromhos) | Milligrams per liter: Dissolved calcium (Ca) | Dissolved magnesium (Mg) | Dissolved sodium (Na) | Dissolved potassium (K) | Alkalinity as $CaCO_3$ | Dissolved sulfate ($SO_4$) | Dissolved chloride (Cl) | Dissolved boron (B) | Dissolved silica ($SiO_2$) | Hardness as $CaCO_3$ | Noncarbonate hardness as $CaCO_3$ | Dissolved solids (calculated sum) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (D-16-6)22cda-S1 | 10-14-77 | Kb | | 7.2 | 600 | 64 | 27 | 4.8 | 1.0 | 250 | 15 | 4.8 | <0.02 | 7.7 | 270 | 17 | 278 |
| 34bdc-S1 | 6-20-79 | TKn | 5.0 | 7.6 | 470 | 64 | 19 | 3.6 | 0.6 | 220 | 25 | 3.5 | < .02 | 5.2 | 240 | 18 | 254 |
| 34cad-S1 | 9-6-78 | Kp | 8.5 | 7.6 | 565 | 87 | 22 | 3.7 | 1.8 | 290 | 86 | 3.8 | < .05 | 7.2 | 310 | 78 | 350 |
| 34dda-S1 | 10-11-77 | Kc | 6.5 | 7.4 | 540 | 54 | 30 | 4.8 | 1.6 | 300 | 14 | 4.4 | < .02 | 7.5 | 260 | 0 | 249 |
| (D-17-6)3acb-S1 | 6-21-79 | Kp | 6.0 | 7.6 | 530 | 75 | 23 | 6.2 | 1.1 | 270 | 17 | 4.4 | .03 | 6.5 | 280 | 12 | 296 |
| 3add-S1 | 11-10-77 | Kc | 6.5 | 7.5 | 600 | 79 | 32 | 6.6 | 1.2 | 300 | 29 | 5.9 | .03 | 7.2 | 330 | 26 | 344 |
| 3cbd-S1 | 7-31-79 | TKn | 7.0 | 7.4 | 470 | 81 | 21 | 7.5 | .6 | 290 | 20 | 4.4 | .03 | 5.5 | 290 | 0 | 315 |
| 14ddd-S1 | 7-14-81 | Kb | 8.5 | 7.3 | 650 | 67 | 39 | 15 | 1.8 | 280 | 65 | 9.5 | .01 | 7.0 | 330 | 48 | 373 |
| 15cbd-S1 | 7-13-79 | TKn | 13.5 | 7.4 | 680 | 85 | 36 | 18 | 1.4 | 350 | 43 | 11 | .04 | 8.4 | 360 | 11 | 414 |
| 15dda-S1 | 7-5-79 | Kp | 8.0 | 7.8 | 650 | 66 | 42 | 17 | .9 | 310 | 46 | 23 | .04 | 8.1 | 340 | 28 | 390 |
| 21abb-S1 | 7-14-81 | TKn | 7.5 | 7.4 | 630 | 54 | 27 | 56 | 1.7 | 320 | 1.0 | 24 | .02 | 6.5 | 250 | 0 | 363 |
| 21dcd-S1 | 7-14-81 | TKn | 7.0 | 7.4 | 560 | 41 | 34 | 18 | .7 | 230 | .7 | 28 | .02 | 6.3 | 240 | 12 | 267 |
| 22cdc-S1 | 7-14-81 | TKn | 8.0 | 7.5 | 495 | 44 | 31 | 17 | 1.1 | 240 | 1.1 | 11 | .01 | 6.5 | 240 | 0 | 256 |
| 26cba-S1 | 7-14-81 | TKn | 11.0 | 7.6 | 600 | 53 | 37 | 19 | .8 | 290 | 10 | 9.3 | .03 | 7.6 | 280 | 0 | 312 |
| 26cbb-S1 | 7-14-81 | TKn | 7.5 | 7.5 | 640 | 38 | 34 | 42 | .8 | 300 | .8 | 8.4 | .03 | 8.1 | 230 | 0 | 313 |
| 27baa-1 | 10-16-82 | Ks | 12.0 | 7.9 | 570 | 27 | 21 | 67 | 4.0 | 287 | 10 | 9.7 | .21 | 8.8 | 150 | 0 | 570 |
| | 10-20-82 | Ks, Kb | 11.5 | 8.0 | 550 | 25 | 18 | 70 | 4.2 | 286 | <5 | 7.6 | .19 | 8.2 | 140 | 0 | 550 |
| 27cbb-S1 | 7-15-81 | TKn | 7.0 | 7.7 | 680 | 48 | 35 | 49 | .8 | 320 | 7.2 | 21 | .02 | 8.2 | 260 | 0 | 356 |
| 27ccc-S1 | 7-15-81 | TKn | 7.5 | 7.7 | 665 | 50 | 34 | 49 | 1.0 | 320 | 2.4 | 21 | .02 | 8.2 | 270 | 0 | 358 |
| 27cdd-S1 | 7-15-81 | TKn | 8.5 | 7.6 | 710 | 47 | 44 | 41 | .7 | 330 | 5.4 | 22 | .02 | 8.1 | 300 | 0 | 367 |
| 28bac-S1 | 7-16-81 | TKn | 10.0 | 7.7 | 740 | 60 | 52 | 40 | .7 | 360 | 1.9 | 29 | .03 | 8.5 | 360 | 4 | 409 |
| 28bad-2 | 10-30-82 | Kp | 8.0 | 7.6 | 730 | 51 | 29 | 44 | 26 | 288 | 70 | 22 | .09 | 5.5 | 250 | 0 | 422 |
| 28bbc-S2 | 7-16-81 | Kp | 10.5 | 7.6 | 595 | 59 | 36 | 17 | .8 | 310 | 59 | 19 | .00 | 6.4 | 300 | 56 | 342 |
| 29cbb-1 | 8-10-82 | Qa | 9.0 | 8.4 | 850 | 61 | 71 | 51 | 2.8 | 239 | 170 | 67 | .07 | 7.1 | 440 | 210 | 575 |
| 35cbb-S1 | 7-15-81 | TKn | 12.0 | 7.7 | 780 | 38 | 40 | 78 | 1.1 | 330 | 13 | 40 | .05 | 7.2 | 260 | 0 | 416 |
| 35ccb-S1 | 7-15-81 | TKn | 7.5 | 7.6 | 705 | 43 | 40 | 47 | 1.2 | 270 | 40 | 34 | .03 | 6.9 | 270 | 2 | 375 |
| Mine 36aca | 8-21-81 | Kb | 11.0 | 8.0 | 475 | 26 | 14 | 54 | 8.6 | 240 | 1.0 | 3.7 | .36 | 8.5 | 120 | 0 | 262 |
| 36dbb | 8-21-81 | Kb | 11.0 | 7.9 | 470 | 23 | 14 | 54 | 17.0 | 240 | 1.0 | 3.2 | .27 | 9.1 | 120 | 0 | 255 |
| (D-18-6)2bbd-S1 | 7-15-81 | TKn | 9.0 | 7.5 | 1140 | 67 | 45 | 120 | 1.5 | 350 | 190 | 52 | .07 | 8.9 | 350 | 3 | 694 |
| 4bac-1 | 10-25-81 | Ks, Kb | 13.5 | 7.6 | 510 | 45 | 32 | 16 | 3.7 | 260 | 11 | 8.1 | .04 | 9.3 | 240 | 0 | 282 |
| 4bbc-S1 | 7-13-81 | Kb | 17.0 | 7.1 | 870 | 97 | 53 | 15 | 2.4 | 320 | 100 | 20 | .02 | 7.8 | 460 | 140 | 488 |
| 11aac | 7-13-81 | Kb | 9.5 | 7.5 | 605 | 53 | 36 | 20 | 3.7 | 220 | 100 | 6.6 | .09 | 8.9 | 280 | 61 | 361 |

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Table 7.--Concentrations of selected trace metals in water from wells, springs, and underground mines in the Trail Mountain area

Water-bearing zone(s): Ks, Star Point Sandstone; Kb, Blackhawk Formation; Kp, Price River Formation; TKn, North Horn Formation; Qa, alluvium.

| Well, spring, or site no. | Date of collection | Water-bearing zone(s) | Micrograms per liter | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dissolved aluminum (Al) | Dissolved arsenic (As) | Dissolved barium (Ba) | Dissolved cadmium (Cd) | Dissolved chromium (Cr) | Dissolved hexavalent chromium | Dissolved cobalt (Co) | Dissolved copper (Cu) | Dissolved iron (Fe) | Dissolved lead (Pb) | Dissolved lithium (Li) | Dissolved manganese (Mn) | Dissolved mercury (Hg) | Dissolved nickel (Ni) | Dissolved selenium (Se) | Dissolved silver (Ag) | Dissolved zinc (Zn) |
| (D-17-6) 14ddd-S1 | 7-14-81 | Kb | 0 | 0 | 90 | <1 | 0 | 0 | <3 | 2 | 60 | 0 | 20 | <1 | 0.0 | 2 | 1 | 0 | 10 |
| 21abb-S1 | 7-14-81 | TKn | 0 | 0 | 100 | <1 | 1 | 0 | <3 | 1 | 20 | 0 | 30 | <1 | .1 | 1 | 4 | 0 | 8 |
| 22cdc-S1 | 7-14-81 | TKn | 0 | 1 | 200 | <1 | 12 | 0 | <3 | 1 | <10 | 0 | 20 | 2 | .0 | 1 | 2 | 0 | 6 |
| 26cba-S1 | 7-14-81 | TKn | 0 | 0 | 200 | <1 | 1 | 0 | <3 | 1 | <10 | 0 | 30 | <1 | .1 | 1 | 1 | 0 | 4 |
| 27bda-1 | 10-16-82 | Ks | 20 | 10 | 400 | <1 | <1 | <1 | 6 | 3 | 3000 | 9 | 39 | 140 | <.1 | 16 | 1 | <1 | 190 |
| | 10-20-82 | Ks, Kb | 50 | 2 | 230 | <1 | <1 | <1 | 2 | 4 | 350 | 5 | 30 | 130 | .2 | 5 | <1 | <1 | 54 |
| 27ccc-S1 | 7-15-81 | TKn | 0 | 0 | 100 | <1 | 0 | 0 | <3 | 0 | <10 | 1 | 30 | <1 | .0 | 1 | 1 | 0 | 10 |
| 28bac-S1 | 7-16-81 | TKn | 0 | 0 | 200 | <1 | 0 | 0 | <3 | 1 | <10 | 0 | 30 | <1 | .1 | 2 | 0 | 0 | 6 |
| 28bad-2 | 10-30-82 | Kp | 30 | 2 | 240 | <1 | <1 | <1 | 1 | 200 | 73 | 7 | 38 | 120 | <.1 | 41 | <1 | <1 | 13 |
| 29cbb-1 | 8-10-82 | Qa | 10 | 1 | 28 | <1 | <1 | <1 | 1 | 1 | <3 | 3 | 33 | 170 | <.1 | 1 | 3 | <1 | 440 |
| 35ccb-S1 | 7-15-81 | TKn | 0 | 0 | 90 | <1 | 0 | 0 | <3 | 1 | <10 | 0 | 30 | <1 | .0 | 0 | 3 | 0 | <3 |
| 36acc | 8-21-81 | Kb | 20 | 0 | 760 | <1 | 0 | 0 | <3 | 2 | 30 | 3 | 28 | 5 | .0 | 1 | 0 | 0 | 57 |
| 36dbb | 8-21-81 | Kb | 20 | 0 | 990 | <1 | 0 | 0 | <3 | 2 | 11 | 4 | 29 | 3 | .0 | 1 | 0 | 0 | 14 |
| (D-18-6) 2bbd-S1 | 7-15-81 | TKn | 10 | 1 | 50 | <1 | 2 | 0 | <3 | 0 | <10 | 0 | 50 | 3 | .1 | 0 | 2 | 0 | 3 |
| 4bac-1 | 10-25-81 | Ks, Kb | <10 | 0 | 220 | <1 | <1 | <1 | <3 | 4 | <10 | 2 | 29 | 9 | .0 | 2 | <1 | 1 | 28 |
| 4bbc-S1 | 7-13-81 | Kb | 10 | 0 | 40 | <1 | 0 | 0 | <3 | 1 | <10 | 0 | 30 | 30 | .1 | 3 | 0 | 0 | 30 |
| 11aac | 7-13-81 | Kb | 10 | 0 | 60 | <1 | 1 | 0 | <3 | 2 | <10 | 0 | 40 | <1 | .1 | 2 | 0 | 0 | 6 |

Table 3.--Laboratory determinations of porosity and hydraulic conductivity of core samples from well (D-17-6) 27 bda-1. (Determinations by Core Laboratories, Inc., Dallas, Texas)

Unpublished Records
Subject to Revision

Lithology: Sh, shale; Slt, siltstone; Ss, sandstone; f, fine grained; m, medium grained.

Hydraulic conductivity: I, impermeable to water even at a pressure of 5000 pounds per square inch.

| Formation | Lithology | Depth (feet below land surface) | Porosity (percent) | Hydraulic conductivity (feet per day) | |
|---|---|---|---|---|---|
| | | | | Horizontal | Vertical |
| Blackhawk Formation | Ss, f | 1521 | 14 | $1.5 \times 10^{-2}$ | $3.7 \times 10^{-3}$ |
| | Slt | 1545 | 3 | $9.3 \times 10^{-8}$ | $1.2 \times 10^{-7}$ |
| | Sh | 1786 | 2 | I | I |
| | Ss, f | 1792 | 14 | $1.1 \times 10^{-2}$ | $3.9 \times 10^{-3}$ |
| | Sh | 2170 | 4 | $1.1 \times 10^{-8}$ | – |
| | Slt | 2265 | 2 | $2.0 \times 10^{-7}$ | $2.2 \times 10^{-6}$ |
| Star Point Sandstone | Ss, m | 2466 | 17 | $3.1 \times 10^{-2}$ | $1.1 \times 10^{-2}$ |
| | Ss, m | 2493 | 11 | $1.5 \times 10^{-2}$ | $6.6 \times 10^{-3}$ |

Tract 2 Seep and Spring Water Anayises

October 29, 1985 Survey**

**CHEMTECH**
28 EAST 1500 NORTH
OREM, UTAH 84057
(801) 226-8822

# CERTIFICATE OF ANALYSIS

**SAMPLE IDENTIFICATION**

CLIENT: JBR Consultants
2556 East Oak Creek Circle
Sandy, UT 84092

LAB NO.: U008772

DATE SAMPLED: 10-29-85

TIME SAMPLED:

SAMPLED BY: R.B.

LOCATION: TM-GW-1 (T-5)
Trail Mountain

COMMENTS: Metals-Dissolved

| PARAMETER | LEVEL |
|---|---|
| Alkalinity as $CaCO_3$, mg/l | 246 |
| Ammonia as $NH_3$-N, mg/l | <.1 |
| Arsenic as As, mg/l | <.01 |
| Barium as Ba, mg/l | 0.155 |
| Bicarbonate as $HCO_3$, mg/l | 300 |
| Boron as B, mg/l | 0.33 |
| Cadmium as Cd, mg/l | <.005 |
| Calcium as Ca, mg/l | 30.9 |
| Carbonate as $CO_3$, mg/l | 0 |
| TSS, mg/l | 6.8 |
| Sulfide as S, mg/l | <.05 |
| Settleable Solids, ml/l | <.1 |

| PARAMETER | LEVEL |
|---|---|
| Chloride as Cl, mg/l | 9.3 |
| Chromium as Cr (Hex.), mg/l | -- |
| Chromium as Cr (Total), mg/l | <.005 |
| Conductivity, umhos/cm | 568 |
| Copper as Cu, mg/l | <.005 |
| Fluoride as F, mg/l | 0.21 |
| Hardness as $CaCO_3$, mg/l | 292 |
| Hydroxide as OH, mg/l | 0 |
| Iron as Fe (Dissolved), mg/l | 0.303 |
| Iron as Fe (Total), mg/l | -- |
| Lead as Pb, mg/l | <.01 |
| Magnesium as Mg, mg/l | 37.9 |
| Manganese as Mn, mg/l | <.005 |
| Mercury as Hg, mg/l | <.0002 |
| Nickel as Ni, mg/l | <.005 |
| Nitrate as $NO_3$-N, mg/l | 0.21 |
| Nitrite as $NO_2$-N, mg/l | 0.007 |
| Phosphate as $PO_4$-P, mg/l | 0.011 |
| Potassium as K, mg/l | 1.15 |
| Selenium as Se, mg/l | <.002 |
| Silica as $SiO_2$ (Dissolved), mg/l | 2.36 |
| Silver as Ag, mg/l | -- |
| Sodium as Na, mg/l | 35.4 |
| Sulfate as $SO_4$, mg/l | 42.8 |
| Total Dissolved Solids, mg/l | 386 |
| Turbidity, NTU | -- |
| Zinc as Zn, mg/l | 0.025 |
| pH Units | 7.40 |

CHEMTECH

**CHEMTECH**
28 EAST 1500 NORTH
OREM, UTAH 84057
(801) 226-8822

# CERTIFICATE OF ANALYSIS

**SAMPLE IDENTIFICATION**

CLIENT: JBR Consultants
2556 East Oak Creek Circle
Sandy, UT 84092

LAB NO.: U008774

DATE SAMPLED: 10-29-85

TIME SAMPLED:

SAMPLED BY: R.B.

LOCATION: TM-GW-3 (T-7)
Trail Mountain

COMMENTS: Dissolved Metals

| PARAMETER | LEVEL |
|---|---|
| Alkalinity as $CaCO_3$, mg/l | 298 |
| Ammonia as $NH_3$-N, mg/l | <.1 |
| Arsenic as As, mg/l | <.01 |
| Barium as Ba, mg/l | 0.135 |
| Bicarbonate as $HCO_3$, mg/l | 363 |
| Boron as B, mg/l | 0.24 |
| Cadmium as Cd, mg/l | <.005 |
| Calcium as Ca, mg/l | 25.4 |
| Carbonate as $CO_3$, mg/l | 0 |
| TSS, mg/l | 80 |
| Sulfide as S, mg/l | <.05 |
| Settleable Solids, ml/l | 0.1 |

| PARAMETER | LEVEL |
|---|---|
| Chloride as Cl, mg/l | 14.1 |
| Chromium as Cr (Hex.), mg/l | — |
| Chromium as Cr (Total), mg/l | <.005 |
| Conductivity, umhos/cm | 705 |
| Copper as Cu, mg/l | <.005 |
| Fluoride as F, mg/l | 0.26 |
| Hardness as $CaCO_3$, mg/l | 456 |
| Hydroxide as OH, mg/l | 0 |
| Iron as Fe (Dissolved), mg/l | 0.045 |
| Iron as Fe (Total), mg/l | — |
| Lead as Pb, mg/l | <.01 |
| Magnesium as Mg, mg/l | 50.6 |
| Manganese as Mn, mg/l | <.005 |
| Mercury as Hg, mg/l | <.0002 |
| Nickel as Ni, mg/l | <.005 |
| Nitrate as $NO_3$-N, mg/l | 0.19 |
| Nitrite as $NO_2$-N, mg/l | 0.009 |
| Phosphate as $PO_4$-P, mg/l | <.01 |
| Potassium as K, mg/l | 1.85 |
| Selenium as Se, mg/l | <.002 |
| Silica as $SiO_2$ (Dissolved), mg/l | 3.38 |
| Silver as Ag, mg/l | -- |
| Sodium as Na, mg/l | 50.4 |
| Sulfate as $SO_4$, mg/l | 68.1 |
| Total Dissolved Solids, mg/l | 543 |
| Turbidity, NTU | -- |
| Zinc as Zn, mg/l | 0.018 |
| pH Units | 7.46 |

CHEMTECH

**CHEMTECH**
28 EAST 1500 NORTH
OREM, UTAH 84057
(801) 226-8822

# CERTIFICATE OF ANALYSIS

**SAMPLE IDENTIFICATION**

CLIENT: JBR Consultants
2556 East Oak Creek Circle
Sandy, UT 84092

LAB NO.: U008773

DATE SAMPLED: 10-29-85

TIME SAMPLED: _____

SAMPLED BY: R.B.

LOCATION: TM-GW-2 (T-11)
Trail Mountain

COMMENTS: Metals - Dissolved

| PARAMETER | LEVEL |
|---|---|
| Alkalinity as $CaCO_3$, mg/l | 223 |
| Ammonia as $NH_3$-N, mg/l | <.1 |
| Arsenic as As, mg/l | <.01 |
| Barium as Ba, mg/l | 0.138 |
| Bicarbonate as $HCO_3$, mg/l | 272 |
| Boron as B, mg/l | 0.33 |
| Cadmium as Cd, mg/l | <.005 |
| Calcium as Ca, mg/l | 36.1 |
| Carbonate as $CO_3$, mg/l | 0 |
| TSS, mg/l | 1.2 |
| Sulfide as S, mg/l | <.05 |

| PARAMETER | LEVEL |
|---|---|
| Chloride as Cl, mg/l | 65.7 |
| Chromium as Cr (Hex.), mg/l | -- |
| Chromium as Cr (Total), mg/l | <.005 |
| Conductivity, umhos/cm | 767 |
| Copper as Cu, mg/l | <.005 |
| Fluoride as F, mg/l | 0.14 |
| Hardness as $CaCO_3$, mg/l | 336 |
| Hydroxide as OH, mg/l | 0 |
| Iron as Fe (Dissolved), mg/l | 0.280 |
| Iron as Fe (Total), mg/l | -- |
| Lead as Pb, mg/l | <.01 |
| Magnesium as Mg, mg/l | 44.8 |
| Manganese as Mn, mg/l | <.005 |
| Mercury as Hg, mg/l | <.0002 |
| Nickel as Ni, mg/l | <.005 |
| Nitrate as $NO_3$-N, mg/l | 0.32 |
| Nitrite as $NO_2$-N, mg/l | 0.003 |
| Phosphate as $PO_4$-P, mg/l | 0.013 |
| Potassium as K, mg/l | 2.27 |
| Selenium as Se, mg/l | <.002 |
| Silica as $SiO_2$ (Dissolved), mg/l | 1.04 |
| Silver as Ag, mg/l | -- |
| Sodium as Na, mg/l | 55.9 |
| Sulfate as $SO_4$, mg/l | 72.9 |
| Total Dissolved Solids, mg/l | 493 |
| Turbidity, NTU | -- |
| Zinc as Zn, mg/l | 0.018 |
| pH Units | 7.53 |

CHEMTECH

TRAIL MOUNTAIN COAL COMPANY SPRING MONITORING

| SPRING ID | DATE | ELEV. | WATER BEARING ZONE | DISCHARGE GAL/MIN | SPECIFIC CONDUCT. | TEMP ºC | PH |
|---|---|---|---|---|---|---|---|
| T-0 * | 07-10-79 | | | 4 | 560 | 6 | |
| T-0 *** | 09-30-86 | 9100 | TKn | 1.3 | 535 | 5.7 | 8.7 |
| T-1 ** | 10-28-85 | | | 4 | 516 | 19 | 7.8 |
| T-1 *** | 09-30-86 | 9100 | TKn | 1.82 | 430 | 7.2 | 8.6 |
| T-4 * | 07-18-79 | | | 4 | 580 | 6 | |
| T-4 * | 07-14-81 | | | 1.3 | 640 | 7.5 | |
| T-4 * | 07-30-81 | | | 1.3 | 660 | 7.5 | |
| T-4 * | 08-20-81 | | | 1.1 | 720 | 7 | |
| T-4 * | 09-23-81 | | | 1.2 | 650 | 7.5 | |
| T-4 * | 05-21-82 | | | 5 | 660 | 7 | |
| T-4 * | 06-23-82 | | | 5 | 670 | 6.5 | |
| T-4 * | 07-15-82 | | | 4.8 | 660 | 6 | |
| T-4 * | 08-10-82 | | | 3.6 | 640 | 7.5 | |
| T-4 * | 09-02-82 | | | 2.6 | 660 | 7.5 | |
| T-4 ** | 10-28-85 | | | 2 | 635 | 19 | 7.6 |
| T-4 *** | 09-30-86 | 9200 | TKn | 0.17 | 685 | 6.4 | 7.7 |
| T-5 * | 08-16-79 | | | 4 | 500 | 6.5 | |
| T-5 ** | 10-28-85 | | | 3 | 586 | 18 | 7.6 |
| T-5 *** | 09-30-86 | 9050 | TKn | 1.88 | 620 | 8.1 | 9.4 |
| T-6 * | 07-12-79 | | | 0.5 | 940 | 8 | |
| T-6 * | 07-15-81 | | | 0.6 | 1140 | 9 | |
| T-6 ** | 10-28-85 | | | 5 | 932 | 16 | 7.5 |
| T-6 *** | 9-30-86 | 8100 | TKn | 2.15 | 996 | 7.7 | 8.6 |
| T-7 * | 08-16-79 | | | 3.2 | 650 | 7 | |
| T-7 * | 07-15-81 | | | 2.8 | 680 | 7 | |
| T-7 ** | 10-28-85 | | | 2 | 942 | 16 | 7.4 |
| T-7 *** | 09-30-86 | 8800 | TKn | 1.4 | 831 | 8 | 9.2 |

# TRAIL MOUNTAIN COAL COMPANY SPRING MONITORING

| SPRING ID | DATE | ELEV | WATER BEARING ZONE | DISCHARGE GAL/MIN | SPECIFIC CONDUCT. | TEMP ºC | PH |
|---|---|---|---|---|---|---|---|
| T-10 ** | 10-28-85 | | | 2 | 711 | 16 | 7.6 |
| T-10 *** | 09-30-86 | 8600 | TKn | 0.78 | 730 | 6.1 | 9.3 |
| T-11 * | 07-12-79 | | | 5.1 | 560 | 6.5 | |
| T-11 * | 07-15-81 | | | 2.6 | 700 | 7.5 | |
| T-11 * | 07-30-81 | | | 2.5 | 740 | 7 | |
| T-11 * | 08-20-81 | | | 2.2 | 740 | 8.5 | |
| T-11 * | 09-23-81 | | | 2.6 | 720 | 8 | |
| T-11 * | 05-21-82 | | | 9.7 | 680 | 6.5 | |
| T-11 * | 06-23-82 | | | 6.4 | 690 | 7.5 | |
| T-11 * | 07-15-82 | | | 5.3 | 700 | 7 | |
| T-11 * | 08-10-82 | | | 5 | 690 | 7.5 | |
| T-11 * | 09-02-82 | | | 4.4 | 700 | 8 | |
| T-11 ** | 10-28-85 | | | 8 | 820 | 17 | 7.6 |
| T-11 *** | 09-30-86 | 8700 | TKn | 4 | 865 | 8.4 | 8.8 |
| T-12 ** | 10-28-85 | | | 2 | 822 | 17 | 8.5 |
| T-12 *** | 09-30-86 | 8680 | TKn | 0.67 | 833 | 6.6 | 9.6 |
| T-14 ** | 10-28-85 | | | 1 | 1630 | 13 | 7.4 |
| T-14 *** | 09-30-86 | 8000 | Kp | 1.5 | 405 | 4 | 6.8 |
| T-14A *** | 09-30-86 | 8700 | TKn | 1.43 | 624 | 7.7 | 9 |
| TM-21 * | 07-10-79 | | | 32 | 520 | 6 | |
| TM-21 * | 07-14-81 | | | 12.4 | 560 | 7 | |
| TM-21 * | 07-30-81 | | | 10.3 | 560 | 6.5 | |
| TM-21 * | 08-20-81 | | | 7.6 | 600 | 7 | |
| TM-21 * | 09-23-81 | | | 7.6 | 560 | 6.5 | |
| TM-21 * | 05-21-82 | | | 44 | 570 | 6.5 | |
| TM-21 * | 06-23-82 | | | 28 | 560 | 6.5 | |
| TM-21 * | 07-15-82 | | | 20 | 560 | 6 | |
| TM-21 * | 08-10-82 | | | 12.6 | 620 | 7 | |
| TM-21 * | 09-02-82 | | | 13.5 | 600 | 7 | |
| TM-21 ** | 10-28-85 | | | 2 | 710 | 18 | 7.3 |
| TM-21 *** | 09-30-86 | 9000 | TKn | 1.25 | 734 | 7.3 | 8.2 |

# TRAIL MOUNTAIN COAL COMPANY SPRING MONITORING

| SPRING ID | DATE | ELEV. | WATER BEARING ZONE | DISCHARGE GAL/MIN | SPECIFIC CONDUCT. | TEMP ºC | PH |
|---|---|---|---|---|---|---|---|
| TM-22 * | 07-14-81 | | | 5 | 495 | 8 | |
| TM-22 * | 07-30-81 | | | 6.1 | 520 | 8 | |
| TM-22 * | 08-20-81 | | | 5.3 | 540 | 6 | |
| TM-22 * | 09-23-81 | | | 5.1 | 520 | 6.5 | |
| TM-22 * | 05-21-82 | | | 40 | 520 | 6.5 | |
| TM-22 * | 06-23-82 | | | 28 | 510 | 6.5 | |
| TM-22 * | 07-15-82 | | | 23 | 520 | 6 | |
| TM-22 * | 08-10-82 | | | 11.2 | 600 | 6.5 | |
| TM-22 * | 09-02-82 | | | 12.4 | 510 | 7 | |
| TM-22 ** | 10-28-85 | | | 3 | 521 | 18 | 7.5 |
| TM-22 *** | 09-30-86 | 9200 | TKn | 4 | 555 | 7.7 | 8.7 |
| | | | | | | | |
| TM-23 * | 07-14-81 | | | 80 | 650 | 8.5 | |
| TM-23 * | 07-30-81 | | | 76 | 640 | 8 | |
| TM-23 * | 08-20-81 | | | 73 | 640 | 8 | |
| TM-23 * | 09-24-81 | | | 76 | 660 | 8 | |
| TM-23 * | 05-20-82 | | | 80 | | | |
| TM-23 * | 06-23-82 | | | 76 | 670 | 8 | |
| TM-23 * | 07-17-82 | | | 98 | 670 | 7.5 | |
| TM-23 * | 08-10-82 | | | 98 | 660 | 8.5 | |
| TM-23 * | 09-08-82 | | | 110 | 600 | 8.5 | |
| TM-23 ** | 10-28-85 | | | 4 | 705 | 13 | 7.5 |
| TM-23 *** | 09-30-86 | 7600 | Kb | 22.56 | 694 | 8.2 | 8.7 |

* = USGS

** = JBR

*** = TMCC

NOTE: T-6, TM-21 AND TM-22 ARE DEVELOPED SPRINGS

# CERTIFICATE OF ANALYSIS

STANDARD LABORATORIES, INC.
Box 1140, Huntington, Utah 84528 801-653-2314

Lab. No. 8600
Date Rec'd 10-2-86
Date Sampled 9-30-86
Time Sampled 1345

Client: TRAIL MOUNTAIN COAL CO.
PO BOX 370
ORANGEVILLE, UT 84537

Sample ID: T-6

| | | | |
|---|---|---|---|
| Acidity | < 1.0 mg/l $CaCO_3$ | Aluminum | < 0.05 mg/l |
| Alkalinity, Total | 330 mg/l $CaCO_3$ | Arsenic | < 0.001 mg/l |
| Alkalinity, Bicarbonate | 403 mg/l $CaCO_3$ | Barium | < 0.1 mg/l |
| Alkalinity, Carbonate | < 1.0 mg/l $CaCO_3$ | Beryllium | mg/l |
| Chloride | 55.0 mg/l | Boron | 0.16 mg/l |
| Coliform, Fecal | MPN/100 ml | Cadmium | < 0.005 mg/l |
| Coliform, Total | MPN/100 ml | Calcium | 62 mg/l |
| Conductivity | 1100 umhos/cm | Chromium | < 0.05 mg/l |
| Fluoride | 0.23 mg/l | Copper | < 0.02 mg/l |
| Hardness, Total | mg/l $CaCO_3$ | Iron | 0.06 mg/l |
| Nitrogen, Ammonia | mg/l | Lead | < 0.05 mg/l |
| Nitrogen, Nitrate | 0.11 mg/l | Magnesium | 58 mg/l |
| Nitrogen, Nitrite | mg/l | Manganese | < 0.01 mg/l |
| Oil & Grease | < 0.5 mg/l | Mercury | < 0.2 ug/l |
| pH | 7.10 Units | Nickel | < 0.04 mg/l |
| Phosphorus, Ortho | 0.03 mg/l | Potassium | 2 mg/l |
| Phosphorus, Total | 0.03 mg/l | Selenium | < 0.005 mg/l |
| Solids, Total Dissolved | 618 mg/l | Silica | mg/l |
| Solids, Total Suspended | < 0.5 mg/l | Sodium | 83 mg/l |
| Sulfate | 160 mg/l | Vanadium | < 0.2 mg/l |
| Sulfide | mg/l | Zinc | 0.016 mg/l |
| Turbidity | 1.0 NTU | | |
| Total Cations | 11.52 meq/l | | |
| Total Anions | 11.50 meq/l | | |

Respectfully submitted Bob Cunningham

Analyst:

*Certified Environmental Laboratory*

# CERTIFICATE OF ANALYSIS

## STANDARD LABORATORIES, INC.

Box 1140, Huntington, Utah 84528 801-653-2314

Client: TRAIL MOUNTAIN COAL CO.
PO BOX 370
ORANGEVILLE, UT 84537

Sample ID: T-10

Lab. No. 8601
Date Rec'd 10-2-86
Date Sampled 9-30-86
Time Sampled 1540

| | | | | | |
|---|---|---|---|---|---|
| Acidity | <1.0 | mg/l $CaCO_3$ | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 315 | mg/l $CaCO_3$ | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 384 | mg/l $CaCO_3$ / $HCO_3$ | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/l $CaCO_3$ | Beryllium | | mg/l |
| Chloride | 33.9 | mg/l | Boron | 0.17 | mg/l |
| Coliform, Fecal | | MPN/100 ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100 ml | Calcium | 42 | mg/l |
| Conductivity | 800 | umbos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.22 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mg/l $CaCO_3$ | Iron | 1.80 | mg/l |
| rogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| en, Nitrate | 0.15 | mg/l | Magnesium | 49 | mg/l |
| Nitrogen, Nitrite | | mg/l | Manganese | 0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 7.60 | Units | Nickel | <0.04 | mg/l |
| Phosphorus, Ortho | 0.04 | mg/l | Potassium | 2 | mg/l |
| Phosphorus, Total | 0.04 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 500 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 89.0 | mg/l | Sodium | 41 | mg/l |
| Sulfate | 30 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | <0.005 | mg/l |
| Turbidity | 33 | NTU | | | |
| Total Cations | 7.95 | meq/l | | | |
| Total Anions | 7.89 | meq/l | | | |

Analyst:

Respectfully submitted Bob Cunningham

*Certified Environmental Laboratory*

# CERTIFICATE OF ANALYSIS

## STANDARD LABORATORIES, INC.

Box 1140, Huntington, Utah 84528 801-653-2314

Lab. No. 8602

Date Rec'd 10-2-86

Date Sampled 9-30-86

Time Sampled

Client: TRAIL MOUNTAIN COAL COMPANY Sample ID: T-11
PO BOX 370
ORANGEVILLE, UT 84537

| | | | | | |
|---|---|---|---|---|---|
| Acidity | <1.0 | mg/l $CaCO_3$ | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 275 | mg/l $CaCO_3$ | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 336 | mg/l $CaCO_3$ | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/l $CaCO_3$ | Beryllium | | mg/l |
| Chloride | 88.6 | mg/l | Boron | 0.26 | mg/l |
| Coliform, Fecal | | MPN/100 ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100 ml | Calcium | 50 | mg/l |
| Conductivity | 905 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.23 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mg/l $CaCO_3$ | Iron | 0.21 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.10 | mg/l | Magnesium | 47 | mg/l |
| Nitrogen, Nitrite | | mg/l | Manganese | 0.04 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 7.00 | Units | Nickel | <0.04 | mg/l |
| Phosphorus, Ortho | 0.03 | mg/l | Potassium | 2 | mg/l |
| Phosphorus, Total | 0.04 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 461 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 69.0 | mg/l | Sodium | 60 | mg/l |
| Sulfate | 48 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.009 | mg/l |
| Turbidity | 11 | NTU | | | |
| Total Cations | 9.01 | meq/l | | | |
| Total Anions | 9.01 | meq/l | | | |

Analyst:

Respectfully submitted Bob Cunningham

*Certified Environmental Laboratory*

# CERTIFICATE OF ANALYSIS

## STANDARD LABORATORIES, INC.

Box 1140, Huntington, Utah 84528 801-653-2314

Lab. No. 8603

Date Rec'd 10-2-86

Date Sampled 9-30-86

Time Sampled 1300

Client: TRAIL MOUNTAIN COAL CO.
PO BOX 370
ORANGEVILLE, UT 84537

Sample ID: T-12

| | | | |
|---|---|---|---|
| Acidity | <1.0 mg/l $CaCO_3$ | Aluminum | <0.05 mg/l |
| Alkalinity, Total | 344. mg/l $CaCO_3$ | Arsenic | <0.001 mg/l |
| Alkalinity, Bicarbonate | 420 mg/l ~~$CaCO_3$~~ $HCO_3$ | Barium | <0.1 mg/l |
| Alkalinity, Carbonate | <1.0 mg/l $CaCO_3$ | Beryllium | mg/l |
| Chloride | 57.2 mg/l | Boron | 0.26 mg/l |
| Coliform, Fecal | MPN/100 ml | Cadmium | <0.005 mg/l |
| Coliform, Total | MPN/100 ml | Calcium | 42 mg/l |
| Conductivity | 910 umhos/cm | Chromium | <0.05 mg/l |
| Fluoride | 0.36 mg/l | Copper | <0.02 mg/l |
| Hardness, Total | mg/l $CaCO_3$ | Iron | 0.05 mg/l |
| Nitrogen, Ammonia | mg/l | Lead | <0.05 mg/l |
| Nitrogen, Nitrate | 0.10 mg/l | Magnesium | 47 mg/l |
| Nitrogen, Nitrite | mg/l | Manganese | <0.01 mg/l |
| Oil & Grease | <0.5 mg/l | Mercury | <0.2 ug/l |
| pH | 7.95 Units | Nickel | <0.04 mg/l |
| Phosphorus, Ortho | 0.07 mg/l | Potassium | 2 mg/l |
| Phosphorus, Total | 0.08 mg/l | Selenium | <0.005 mg/l |
| Solids, Total Dissolved | 502 mg/l | Silica | mg/l |
| Solids, Total Suspended | 12.0 mg/l | Sodium | 88 mg/l |
| Sulfate | 60 mg/l | Vanadium | <0.2 mg/l |
| Sulfide | mg/l | Zinc | <0.005 mg/l |
| Turbidity | 5.0 NTU | | |
| Total Cations | 9.83 meq/l | | |
| Total Anions | 9.76 meq/l | | |

Analyst;

Respectfully submitted Bal Cunningham

*Certified Environmental Laboratory*

# CERTIFICATE OF ANALYSIS

## STANDARD LABORATORIES, INC.

Box 1140, Huntington, Utah 84528 801-653-2314

Lab. No. 8606

Date Rec'd 10-2-86

Date Sampled 9-30-86

Time Sampled _____

Client: TRAIL MOUNTAIN COAL CO.
PO BOX 370
ORANGEVILLE, UT 84537

Sample ID: TM23

| | | | | | |
|---|---|---|---|---|---|
| Acidity | | mg/l $CaCO_3$ | Aluminum | | mg/l |
| Alkalinity, Total | | mg/l $CaCO_3$ | Arsenic | | mg/l |
| Alkalinity, Bicarbonate | 359 | mg/l $CaCO_3$/$HCO_3$ | Barium | | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/l $CaCO_3$ | Beryllium | | mg/l |
| Chloride | 14.8 | mg/l | Boron | | mg/l |
| Coliform, Fecal | | MPN/100 ml | Cadmium | | mg/l |
| Coliform, Total | | MPN/100 ml | Calcium | 68 | mg/l |
| Conductivity | | umhos/cm | Chromium | | mg/l |
| Fluoride | | mg/l | Copper | | mg/l |
| Hardness, Total | 355 | mg/l $CaCO_3$ | Iron Diss. | <0.05 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | | mg/l |
| Nitrogen, Nitrate | | mg/l | Magnesium | 40 | mg/l |
| Nitrogen, Nitrite | | mg/l | Manganese | <0.01 | mg/l |
| Oil & Grease | | mg/l | Mercury | | ug/l |
| pH | | Units | Nickel | | mg/l |
| Phosphorus, Ortho | | mg/l | Potassium | 2 | mg/l |
| Phosphorus, Total | | mg/l | Selenium | | mg/l |
| Solids, Total Dissolved | 385 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | | mg/l | Sodium | 14 | mg/l |
| Sulfate | 70 | mg/l | Vanadium | | mg/l |
| Sulfide | | mg/l | Zinc | | mg/l |
| Turbidity | | NTU | | | |
| Total Cations | 7.76 | meq/l | | | |
| Total Anions | 7.77 | meq/l | | | |

Analyst: _____

Respectfully submitted Bob Cunningham

*Certified Environmental Laboratory*

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-0

Lab No. 8629
Date Rec'd 10-07-86
Date Sampled 09-30-86
Time Sampled

| | | | | | |
|---|---|---|---|---|---|
| Acidity | <1.0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 250 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 305 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/lCaCO3 | Beryllium | ---- | mg/l |
| Chloride | 23.3 | mg/l | Boron | 0.10 | mg/l |
| Coliform, Fecal | ---- | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | ---- | MPN/100ml | Calcium | 50.0 | mg/l |
| Conductivity | 550 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.17 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | ---- | mglCaCO3 | Iron | <0.05 | mg/l |
| Nitrogen, Ammonia | ---- | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.12 | mg/l | Magnesium | 31.6 | mg/l |
| Nitrogen, Nitrite | ---- | mg/l | Maganese | 0.07 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.24 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.09 | mg/l | Potassium | 2.6 | mg/l |
| Phosphorus, Total | 0.10 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 294 | mg/l | Silica | ---- | mg/l |
| Solids, Total Suspended | 18.0 | mg/l | Sodium | 18.8 | mg/l |
| Sulfate | 17 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | ---- | mg/l | Zinc | <0.005 | mg/l |
| Turbidity | 18 | NTU | | | |
| Total Cations | 5.98 | meq/l | | | |
| Total Anions | 6.02 | meq/l | | | |

Respectfully submitted David L. Ramey

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-1

Lab No. 8630
Date Rec'd 10-07-86
Date Sampled 09-30-86
Time Sampled

| | | | | | |
|---|---|---|---|---|---|
| Acidity | <1.0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 304 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 371 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 10.8 | mg/l | Boron | 0.09 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 50.0 | mg/l |
| Conductivity | 620 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.27 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | 0.11 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.10 | mg/l | Magnesium | 35.3 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | 0.03 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.20 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.09 | mg/l | Potassium | 2.9 | mg/l |
| Phosphorus, Total | 0.09 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 348 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 18.0 | mg/l | Sodium | 37.3 | mg/l |
| Sulfate | 30 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.014 | mg/l |
| Turbidity | 17 | NTU | | | |
| Total Cations | 7.09 | meq/l | | | |
| Total Anions | 7.02 | meq/l | | | |

Respectfully submitted David L. Janney

1645 West 2200 South. Salt Lake City. Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-4

Lab No. 8631
Date Rec'd 10-07-8
Date Sampled 09-30-8
Time Sampled

| | | | | | |
|---|---|---|---|---|---|
| Acidity | <1.0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 263 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 321 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 16.5 | mg/l | Boron | 0.10 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 36.0 | mg/l |
| Conductivity | 700 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.29 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | 0.33 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.11 | mg/l | Magnesium | 19.5 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | 0.07 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.26 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.08 | mg/l | Potassium | 5.5 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 400 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 50.0 | mg/l | Sodium | 88.0 | mg/l |
| Sulfate | 75 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.006 | mg/l |
| Turbidity | 45 | NTU | | | |
| Total Cations | 7.36 | meq/l | | | |
| Total Anions | 7.30 | meq/l | | | |

Respectfully submitted David Darney

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-5

Lab No. 8632
Date Rec'd 10-07-86
Date Sampled 09-30-86
Time Sampled

| | | | | | |
|---|---|---|---|---|---|
| Acidity | <1.0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 374 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 456 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 15.3 | mg/l | Boron | 0.10 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 54.0 | mg/l |
| Conductivity | 750 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.29 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | 0.11 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.12 | mg/l | Magnesium | 45.0 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | 0.04 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.20 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.09 | mg/l | Potassium | 4.0 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 412 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 40.0 | mg/l | Sodium | 44.8 | mg/l |
| Sulfate | 25 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.015 | mg/l |
| Turbidity | 38 | NTU | | | |
| Total Cations | 8.45 | meq/l | | | |
| Total Anions | 8.45 | meq/l | | | |

Respectfully submitted David Spann

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utan 84537

Sample ID: T-7

Lab No. 8633
Date Rec'd 10-07-86
Date Sampled 09-30-86
Time Sampled

| | | | | | |
|---|---|---|---|---|---|
| Acidity | <1.0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 367 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 448 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 26.6 | mg/l | Boron | 0.06 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 34.0 | mg/l |
| Conductivity | 850 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.34 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | 0.06 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.06 | mg/l | Magnesium | 49.9 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | <0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.21 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.07 | mg/l | Potassium | 3.5 | mg/l |
| Phosphorus, Total | 0.09 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 424 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 1.0 | mg/l | Sodium | 63.9 | mg/l |
| Sulfate | 25 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.013 | mg/l |
| Turbidity | 1.0 | NTU | | | |
| Total Cations | 8.66 | meq/l | | | |
| Total Anions | 8.63 | meq/l | | | |

Respectfully submitted David D Parry

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-14

Lab No. 8634
Date Rec'd 10-07-8
Date Sampled 09-30-8
Time Sampled

| | | | | | |
|---|---|---|---|---|---|
| Acidity | <1.0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 366 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 446 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | <1.0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 65.4 | mg/l | Boron | 0.08 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 56.0 | mg/l |
| Conductivity | 1550 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.29 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | <0.05 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.04 | mg/l | Magnesium | 86.3 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | 0.02 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.25 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.07 | mg/l | Potassium | 6.5 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 877 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | <0.5 | mg/l | Sodium | 132.9 | mg/l |
| Sulfate | 310 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.009 | mg/l |
| Turbidity | 1.0 | NTU | | | |
| Total Cations | 15.84 | meq/l | | | |
| Total Anions | 15.63 | meq/l | | | |

Respectfully submitted David L. Ramsey

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-0

Lab No. 1003
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled 1025

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 260 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 327 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 23.1 | mg/l | Boron | 0.10 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 50.0 | mg/l |
| Conductivity | 562 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.17 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | 0.07 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.10 | mg/l | Magnesium | 32.8 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | 0.05 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.24 | Units | Nickel | <0.04 | mg/l |
| Phospnorus Ortho | 0.10 | mg/l | Potassium | 2.5 | mg/l |
| Phosphorus, Total | 0.14 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 297 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 10.0 | mg/l | Sodium | 19.4 | mg/l |
| Sulfate | 13 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | <0.005 | mg/l |
| Turbidity | 16 | NTU | | | |
| Total Cations | 6.10 | meq/l | | | |
| Total Anions | 6.13 | meq/l | | | |

Respectfully submitted David L. Janney

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-1

Lab No. 1004
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled 1100

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 414 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 492 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 10 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 11.0 | mg/l | Boron | 0.11 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 50.0 | mg/l |
| Conductivity | 726 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.25 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | <0.05 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.10 | mg/l | Magnesium | 35.3 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | <0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.43 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.09 | mg/l | Potassium | 2.9 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 395 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 10.0 | mg/l | Sodium | 38.4 | mg/l |
| Sulfate | 10 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | <0.005 | mg/l |
| Turbidity | 14 | NTU | | | |
| Total Cations | 7.14 | meq/l | | | |
| Total Anions | 7.47 | meq/l | | | |

Respectfully submitted David L. Perry

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-4

Lab No. 1005
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled 1133

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 309 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 377 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 18.0 | mg/l | Boron | 0.11 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 44.0 | mg/l |
| Conductivity | 864 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.26 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | 0.48 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.10 | mg/l | Magnesium | 19.4 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | 0.19 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.29 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.09 | mg/l | Potassium | 5.1 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 456 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 21.0 | mg/l | Sodium | 105.0 | mg/l |
| Sulfate | 80 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.013 | mg/l |
| Turbidity | 30 | NTU | | | |
| Total Cations | 8.49 | meq/l | | | |
| Total Anions | 8.37 | meq/l | | | |

Respectfully submitted David Ramey

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-5

Lab No. 1006
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled 1200

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 424 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 517 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 18.2 | mg/l | Boron | 0.10 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 56.0 | mg/l |
| Conductivity | 972 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.29 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | <0.05 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.08 | mg/l | Magnesium | 53.5 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | <0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.10 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.07 | mg/l | Potassium | 3.7 | mg/l |
| Phosphorus, Total | 0.09 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 469 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 15.0 | mg/l | Sodium | 52.7 | mg/l |
| Sulfate | 30 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.010 | mg/l |
| Turbidity | 20 | NTU | | | |
| Total Cations | 9.58 | meq/l | | | |
| Total Anions | 9.63 | meq/l | | | |

Respectfully submitted David L. Janney

1645 West 2200 South. Salt Lake City. Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-6

Lab No. 1007
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled 1335

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 334 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 407 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 56.2 | mg/l | Boron | 0.09 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 60.0 | mg/l |
| Conductivity | 1086 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.30 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | 0.12 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.09 | mg/l | Magnesium | 54.7 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | <0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.26 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.07 | mg/l | Potassium | 3.9 | mg/l |
| Phosphorus, Total | 0.09 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 570 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | <0.5 | mg/l | Sodium | 74.5 | mg/l |
| Sulfate | 120 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.015 | mg/l |
| Turbidity | 0.8 | NTU | | | |
| Total Cations | 10.83 | meq/l | | | |
| Total Anions | 10.78 | meq/l | | | |

Respectfully submitted David Ramsey

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-7

Lab No. 1008
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled 1215

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 388 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 473 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 | Beryllium | | mg/l |
| [illegible]ride | 25.2 | mg/l | Boron | 0.08 | mg/l |
| [illegible]form, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 40.0 | mg/l |
| Conductivity | 870 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.24 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | <0.05 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.10 | mg/l | Magnesium | 48.6 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | <0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.29 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.08 | mg/l | Potassium | 3.4 | mg/l |
| Phosphorus, Total | 0.09 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 442 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | <0.5 | mg/l | Sodium | 66.7 | mg/l |
| Sulfate | 25 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | <0.005 | mg/l |
| Turbidity | 0.6 | NTU | | | |
| Total Cations | 8.99 | meq/l | | | |
| Total Anions | 9.00 | meq/l | | | |

Respectfully submitted David Ramey

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-10

Lab No. 1009
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled 1340

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 340 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 415 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 34.5 | mg/l | Boron | 0.10 | mg/l |
| [illegible]iform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| [illegible]iform, Total | | MPN/100ml | Calcium | 54.0 | mg/l |
| Conductivity | 840 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.26 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | <0.05 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.06 | mg/l | Magnesium | 45.0 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | <0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.25 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.09 | mg/l | Potassium | 3.4 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 395 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 1.0 | mg/l | Sodium | 37.3 | mg/l |
| Sulfate | 16 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.016 | mg/l |
| Turbidity | 1.0 | NTU | | | |
| Total Cations | 8.11 | meq/l | | | |
| Total Anions | 8.12 | meq/l | | | |

Respectfully submitted David A. Ramsey

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-11

Lab No. 1010
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled 1300

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 278 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 339 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 91.0 | mg/l | Boron | 0.10 | mg/l |
| Coliform, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| Coliform, Total | | MPN/100ml | Calcium | 50.0 | mg/l |
| Conductivity | 936 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.30 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | <0.05 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.08 | mg/l | Magnesium | 43.8 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | <0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.23 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.08 | mg/l | Potassium | 3.7 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 430 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | 1.0 | mg/l | Sodium | 55.0 | mg/l |
| Sulfate | 20 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | <0.005 | mg/l |
| Turbidity | 0.8 | NTU | | | |
| Total Cations | 8.58 | meq/l | | | |
| Total Anions | 8.55 | meq/l | | | |

Respectfully submitted David L. Ramey

1645 West 2200 South. Salt Lake City. Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-14

Lab No. 1011
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled

| | | |
|---|---|---|
| Acidity | 0 | mg/lCaCO3 |
| Alkalinity, Total | 405 | mg/lCaCO3 |
| Alkalinity, Bicarbonate | 495 | mg/HCO3 |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 |
| Chloride | 56.2 | mg/l |
| [illegible]liform, Fecal | | MPN/100ml |
| [illegible]liform, Total | | MPN/100ml |
| Conductivity | 1560 | umhos/cm |
| Fluoride | 0.26 | mg/l |
| Hardness, Total | | mglCaCO3 |
| Nitrogen, Ammonia | | mg/l |
| Nitrogen, Nitrate | 0.06 | mg/l |
| Nitrogen, Nitrite | | mg/l |
| Oil & Grease | <0.5 | mg/l |
| pH | 8.30 | Units |
| Phosphorus Ortho | 0.07 | mg/l |
| Phosphorus, Total | 0.09 | mg/l |
| Solids, Total Dissolved | 890 | mg/l |
| Solids, Total Suspended | <0.5 | mg/l |
| Sulfate | 300 | mg/l |
| Sulfide | | mg/l |
| Turbidity | 0.6 | NTU |
| Total Cations | 16.21 | meq/l |
| Total Anions | 15.95 | meq/l |

| | | |
|---|---|---|
| Aluminum | <0.05 | mg/l |
| Arsenic | <0.001 | mg/l |
| Barium | <0.1 | mg/l |
| Beryllium | | mg/l |
| Boron | 0.12 | mg/l |
| Cadmium | <0.005 | mg/l |
| Calcium | 72.0 | mg/l |
| Chromium | <0.05 | mg/l |
| Copper | <0.02 | mg/l |
| Iron | 0.07 | mg/l |
| Lead | <0.05 | mg/l |
| Magnesium | 82.7 | mg/l |
| Maganese | <0.01 | mg/l |
| Mercury | <0.2 | ug/l |
| Nickel | <0.04 | mg/l |
| Potassium | 6.3 | mg/l |
| Selenium | <0.005 | mg/l |
| Silica | | mg/l |
| Sodium | 130.1 | mg/l |
| Vanadium | <0.2 | mg/l |
| Zinc | 0.015 | mg/l |

Respectfully submitted David Passey

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:

Trail Mountain Coal Co.
P.O. Box 370
Orangeville, Utah 84537

Sample ID: T-16

Lab No. 1012
Date Rec'd 10-21-86
Date Sampled 10-17-86
Time Sampled

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/lCaCO3 | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 343 | mg/lCaCO3 | Arsenic | <0.001 | mg/l |
| Alkalinity, Bicarbonate | 418 | mg/HCO3 | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/lCaCO3 | Beryllium | | mg/l |
| Chloride | 58.6 | mg/l | Boron | 0.11 | mg/l |
| [illegible] form, Fecal | | MPN/100ml | Cadmium | <0.005 | mg/l |
| [illegible]form, Total | | MPN/100ml | Calcium | 48.0 | mg/l |
| Conductivity | 960 | umhos/cm | Chromium | <0.05 | mg/l |
| Fluoride | 0.26 | mg/l | Copper | <0.02 | mg/l |
| Hardness, Total | | mglCaCO3 | Iron | <0.05 | mg/l |
| Nitrogen, Ammonia | | mg/l | Lead | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.06 | mg/l | Magnesium | 35.3 | mg/l |
| Nitrogen, Nitrite | | mg/l | Maganese | <0.01 | mg/l |
| Oil & Grease | <0.5 | mg/l | Mercury | <0.2 | ug/l |
| pH | 8.31 | Units | Nickel | <0.04 | mg/l |
| Phosphorus Ortho | 0.07 | mg/l | Potassium | 3.7 | mg/l |
| Phosphorus, Total | 0.10 | mg/l | Selenium | <0.005 | mg/l |
| Solids, Total Dissolved | 485 | mg/l | Silica | | mg/l |
| Solids, Total Suspended | <0.5 | mg/l | Sodium | 92.7 | mg/l |
| Sulfate | 40 | mg/l | Vanadium | <0.2 | mg/l |
| Sulfide | | mg/l | Zinc | 0.010 | mg/l |
| Turbidity | 0.6 | NTU | | | |
| Total Cations | 9.42 | meq/l | | | |
| Total Anions | 9.36 | meq/l | | | |

Respectfully submitted David A Parry

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537
Attn: Allen Childs

Lab. No. 1018
Date Rec'd. 11-17-86
Date Sampled 11-11-86
Time Sampled

Sample ID: T - 1

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/$CaCO_3$ | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 318 | mg/l$CaCO_3$ | Arsenic | <0.002 | mg/l |
| Alkalinity, Bicarbonate | 388 | mg/$HCO_3$ | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/l$CaCO_3$ | Boron | <0.2 | mg/l |
| Chloride | 8.8 | mg/l | Cadmium | <0.005 | mg/l |
| Conductivity | 654 | umhos/cm | Calcium | 52.0 | mg/l |
| Fluoride | 0.29 | mg/l | Chromium | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.08 | mg/l | Copper | <0.03 | mg/l |
| pH | 8.17 | Units | Iron | 0.18 | mg/l |
| Phosphorus, Ortho | 0.08 | mg/l | Lead | <0.05 | mg/l |
| Phosphorus, Total | 0.10 | mg/l | Magnesium | 35.0 | mg/l |
| Solids, Total Dissolved | 368 | mg/l | Manganese | <0.01 | mg/l |
| Solids, Total Suspended | 6.0 | mg/l | Mercury | <0.2 | ug/l |
| Sulfate | 35 | mg/l | Nickel | <0.04 | mg/l |
| Turbidity | 3.0 | NTU | Potassium | 1.7 | mg/l |
| | | | Selenium | <0.005 | mg/l |
| Total Cations | 5.62 | meq/l | Sodium | 42.2 | mg/l |
| Total Anions | 5.78 | meq/l | Vanadium | <0.2 | mg/l |
| | | | Zinc | <0.01 | mg/l |

Supervisor David Ramsey
Reviewed and approved 12-24-86

Respectfully submitted

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537
Attn: Allen Childs

Lab. No. 1019
Date Rec'd. 11-17-86
Date Sampled 11-11-86
Time Sampled

Sample ID: T - 5

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/$CaCO_3$ | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 435 | mg/l$CaCO_3$ | Arsenic | <0.002 | mg/l |
| Alkalinity, Bicarbonate | 531 | mg/$HCO_3$ | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/l$CaCO_3$ | Boron | <0.2 | mg/l |
| Chloride | 15.4 | mg/l | Cadmium | <0.005 | mg/l |
| Conductivity | 872 | umhos/cm | Calcium | 72.0 | mg/l |
| Fluoride | 0.33 | mg/l | Chromium | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.08 | mg/l | Copper | <0.03 | mg/l |
| pH | 8.00 | Units | Iron | 0.05 | mg/l |
| Phosphorus, Ortho | 0.11 | mg/l | Lead | <0.05 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Magnesium | 57.4 | mg/l |
| Solids, Total Dissolved | 512 | mg/l | Manganese | <0.01 | mg/l |
| Solids, Total Suspended | 147.0 | mg/l | Mercury | <0.2 | ug/l |
| Sulfate | 43 | mg/l | Nickel | <0.04 | mg/l |
| Turbidity | 74 | NTU | Potassium | 2.7 | mg/l |
| | | | Selenium | <0.005 | mg/l |
| Total Cations | 10.85 | meq/l | Sodium | 56.7 | mg/l |
| Total Anions | 10.02 | meq/l | Vanadium | <0.2 | mg/l |
| | | | Zinc | <0.01 | mg/l |

Supervisor David L. Janney
Reviewed and approved 12-24-86

Respectfully submitted

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537
Attn: Allen Childs

Lab. No. 1020
Date Rec'd. 11-17-86
Date Sampled 11-11-86
Time Sampled

Sample ID: T - 7

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/$CaCO_3$ | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 409 | mg/l$CaCO_3$ | Arsenic | <0.002 | mg/l |
| Alkalinity, Bicarbonate | 489 | mg/$HCO_3$ | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 8 | mg/l$CaCO_3$ | Boron | <0.2 | mg/l |
| Chloride | 21.7 | mg/l | Cadmium | <0.005 | mg/l |
| Conductivity | 861 | umhos/cm | Calcium | 46.0 | mg/l |
| Fluoride | 0.39 | mg/l | Chromium | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.08 | mg/l | Copper | <0.03 | mg/l |
| pH | 8.34 | Units | Iron | <0.05 | mg/l |
| Phosphorus, Ortho | 0.10 | mg/l | Lead | <0.05 | mg/l |
| Phosphorus, Total | 0.12 | mg/l | Magnesium | 52.3 | mg/l |
| Solids, Total Dissolved | 480 | mg/l | Manganese | <0.01 | mg/l |
| Solids, Total Suspended | 19.0 | mg/l | Mercury | <0.2 | ug/l |
| Sulfate | 40 | mg/l | Nickel | <0.04 | mg/l |
| Turbidity | 8.0 | NTU | Potassium | 2.4 | mg/l |
| | | | Selenium | <0.005 | mg/l |
| Total Cations | 9.78 | meq/l | Sodium | 71.8 | mg/l |
| Total Anions | 9.64 | meq/l | Vanadium | <0.2 | mg/l |
| | | | Zinc | 0.015 | mg/l |

Supervisor David Dancy
Reviewed and approved 12-24-86

Respectfully submitted

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537
Attn: Allen Childs

Lab. No. 1021
Date Rec'd. 11-17-86
Date Sampled 11-11-86
Time Sampled

Sample ID: T - 11

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/$CaCO_3$ | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 281 | mg/l$CaCO_3$ | Arsenic | <0.002 | mg/l |
| Alkalinity, Bicarbonate | 343 | mg/$HCO_3$ | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/l$CaCO_3$ | Boron | <0.2 | mg/l |
| Chloride | 77.3 | mg/l | Cadmium | <0.005 | mg/l |
| Conductivity | 774 | umhos/cm | Calcium | 48.0 | mg/l |
| Fluoride | 0.26 | mg/l | Chromium | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.08 | mg/l | Copper | <0.03 | mg/l |
| pH | 8.14 | Units | Iron | 0.05 | mg/l |
| Phosphorus, Ortho | 0.07 | mg/l | Lead | <0.05 | mg/l |
| Phosphorus, Total | 0.15 | mg/l | Magnesium | 47.4 | mg/l |
| Solids, Total Dissolved | 500 | mg/l | Manganese | <0.01 | mg/l |
| Solids, Total Suspended | <5.0 | mg/l | Mercury | <0.2 | ug/l |
| Sulfate | 100 | mg/l | Nickel | <0.04 | mg/l |
| Turbidity | 1.0 | NTU | Potassium | 2.5 | mg/l |
| | | | Selenium | <0.005 | mg/l |
| Total Cations | 8.84 | meq/l | Sodium | 57.0 | mg/l |
| Total Anions | 8.48 | meq/l | Vanadium | <0.2 | mg/l |
| | | | Zinc | <0.01 | mg/l |

Supervisor David L. Darney
Reviewed and approved 12-24-86

Respectfully submitted

1645 West 2200 South. Salt Lake City. Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537
Attn: Allen Childs

Lab. No. 1022
Date Rec'd. 11-17-86
Date Sampled 11-11-86
Time Sampled

Sample ID: T - 15

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/$CaCO_3$ | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 338 | mg/l$CaCO_3$ | Arsenic | <0.002 | mg/l |
| Alkalinity, Bicarbonate | 412 | mg/$HCO_3$ | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/l$CaCO_3$ | Boron | <0.2 | mg/l |
| Chloride | 52.6 | mg/l | Cadmium | <0.005 | mg/l |
| Conductivity | 872 | umhos/cm | Calcium | 48.0 | mg/l |
| Fluoride | 0.40 | mg/l | Chromium | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.09 | mg/l | Copper | <0.03 | mg/l |
| pH | 8.08 | Units | Iron | <0.05 | mg/l |
| Phosphorus, Ortho | 0.07 | mg/l | Lead | <0.05 | mg/l |
| Phosphorus, Total | 0.10 | mg/l | Magnesium | 36.2 | mg/l |
| Solids, Total Dissolved | 500 | mg/l | Manganese | <0.01 | mg/l |
| Solids, Total Suspended | 17.0 | mg/l | Mercury | <0.2 | ug/l |
| Sulfate | 61 | mg/l | Nickel | <0.04 | mg/l |
| Turbidity | 9.0 | NTU | Potassium | 2.5 | mg/l |
| | | | Selenium | <0.005 | mg/l |
| Total Cations | 9.50 | meq/l | Sodium | 93.3 | mg/l |
| Total Anions | 9.53 | meq/l | Vanadium | <0.2 | mg/l |
| | | | Zinc | <0.01 | mg/l |

Supervisor David Damron
Reviewed and approved 12-24-86

Respectfully submitted

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050

MOUNTAIN STATES ANALYTICAL

# CERTIFICATE OF ANALYSIS

Client:
Trail Mountain Coal Company
P.O. Box 370
Orangeville, Utah 84537
Attn: Allen Childs

Lab. No. 1023
Date Rec'd. 11-17-86
Date Sampled 11-11-86
Time Sampled

Sample ID: T - 17

| | | | | | |
|---|---|---|---|---|---|
| Acidity | 0 | mg/$CaCO_3$ | Aluminum | <0.05 | mg/l |
| Alkalinity, Total | 246 | mg/l$CaCO_3$ | Arsenic | <0.002 | mg/l |
| Alkalinity, Bicarbonate | 300 | mg/$HCO_3$ | Barium | <0.1 | mg/l |
| Alkalinity, Carbonate | 0 | mg/l$CaCO_3$ | Boron | <0.2 | mg/l |
| Chloride | 11.9 | mg/l | Cadmium | <0.005 | mg/l |
| Conductivity | 458 | umhos/cm | Calcium | 42.0 | mg/l |
| Fluoride | 0.20 | mg/l | Chromium | <0.05 | mg/l |
| Nitrogen, Nitrate | 0.11 | mg/l | Copper | <0.03 | mg/l |
| pH | 8.12 | Units | Iron | <0.05 | mg/l |
| Phosphorus, Ortho | 0.08 | mg/l | Lead | <0.05 | mg/l |
| Phosphorus, Total | 0.11 | mg/l | Magnesium | 33.8 | mg/l |
| Solids, Total Dissolved | 280 | mg/l | Manganese | <0.01 | mg/l |
| Solids, Total Suspended | 5.0 | mg/l | Mercury | <0.2 | ug/l |
| Sulfate | 22 | mg/l | Nickel | <0.04 | mg/l |
| Turbidity | 2.5 | NTU | Potassium | 1.4 | mg/l |
| | | | Selenium | <0.005 | mg/l |
| Total Cations | 5.69 | meq/l | Sodium | 17.7 | mg/l |
| Total Anions | 5.73 | meq/l | Vanadium | <0.2 | mg/l |
| | | | Zinc | <0.01 | mg/l |

Supervisor David D. Darwin
Reviewed and approved 12-24-86

Respectfully submitted

1645 West 2200 South. Salt Lake City. Utah 84119 (801) 973-0050

# APPENDIX 7-10

# PROBABLE HYDROLOGIC CONSEQUENCES

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

# PROBABLE HYDROLOGIC CONSEQUENCES OF MINING AT THE TRAIL MOUNTAIN MINE, EMERY COUNTY, UTAH

Prepared for

TRAIL MOUNTAIN COAL COMPANY
Orangeville, Utah

Prepared by

EARTHFAX ENGINEERING, INC.
Salt Lake City, Utah

Modified with Additional Data Collected by Acro Coal & PacifiCorp

November 1995

INCORPORATED
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UTAH DIVISION OIL, GAS AND MINING

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UTAH DIVISION OIL, GAS AND MINING

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PROBABLE HYDROLOGIC CONSEQUENCES OF MINING
AT THE TRAIL MOUNTAIN MINE,
EMERY COUNTY, UTAH

# 1.0 INTRODUCTION

The purpose of this document is to present an assessment of the probable hydrologic consequences of the Trail Mountain mining operation. Where appropriate, the potential cumulative impacts of Tract 1 (Lease U-082996 and State 22603), Tract 2 (Lease U-49332) and from Lease UTU-64375. will be addressed.

This document is divided into five sections, including this introduction. Section 2.0 presents probable groundwater impacts and proposed groundwater monitoring plans. A similar discussion of surface water is provided in Section 3.0. Conclusions and references are listed in Sections 4.0 and 5.0, respectively.

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# 2.0 GROUNDWATER

## 2.1 Probable Impacts

2.1.1 Background Information. Information presented in Chapters 6 and 7 of the PAP indicates that groundwater in the mine plan and adjacent areas occurs within the Blackhawk Formation (the coal-bearing formation) and the underlying Star Point Sandstone. These two formations are jointly considered an aquifer in the region (Lines, 1985).

According to Doelling (1972), the Blackhawk Formation consists of interbedded layers of sandstone, siltstone, shale, and coal, all of marine origin. The Star Point Sandstone consists of massive medium- to fine-grained sandstone with minor interbedded layers of shale and siltstone near its base. The Star Point also interfingers locally with the Blackhawk in the vicinity of the mine (Lines, 1985).

Lines (1985) tested core samples of the Blackhawk Formation and the Star Point Sandstone taken from a drill hole located approximately 1.5 miles west of the western Tract 2 boundary. Analysis results are presented in Table 2-1. According to the results, the sandstone units within the Blackhawk Formation are five to six orders of magnitude more permeable than the shale and siltstone units. The Star Point Sandstone is one to two times more permeable than the sandstone units of the Blackhawk Formation.

Aquifer tests were conducted by Lines (1985) on selected wells in the vicinity of the Trail Mountain Mine. Due to the low yield of most bedrock in the area, the tests could only be performed as recovery tests following pumping at rates of 5 to 10 gallons per minute for periods less than 5 hours. Nonetheless, the data are useful in determining approximate hydraulic characteristics of bedrock in the mine vicinity.

Based on the transmissivity and thickness data presented by Lines (1985) a hydraulic conductivity of 1.1x10-2 feet per day was calculated for a well completed in the Blackhawk Formation and the Star Point Sandstone in Section 24,Township 17 South, Range 6 East, approximately one-quarter mile north of the Tract 1 permit area. Another test was conducted in a well completed in the Blackhawk-Star Point aquifer in Section 27,Township 17 South, Range 6 East, about 1.5 miles west of the Tract 2 area (the same well from which core was obtained to determine the laboratory hydraulic conductivities provided in Table 2-1). Results of the test indicated a hydraulic conductivity of 1.4x10-2 feet per day. Both of these values compare favorably with the laboratory results reported in Table 2-1.

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Table 2-1. Results of laboratory analyses of selected core samples (from Lines, 1985).

[Determinations by Core Laboratories, Inc., Dallas, Texas]

Lithology: Sh, shale; Slt, siltstone; Ss, sandstone; f, fine grained; m, medium grained.
Hydraulic conductivity: I, impermeable to water even at a pressure of 5,000 pounds per square inch.

| Geologic unit | Lithology | Depth below land surface (feet) | Porosity (percent) | Hydraulic conductivity (feet per day) | |
|---|---|---|---|---|---|
| | | | | Horizontal | Vertical |
| Blackhawk Formation | Ss, f | 1,521 | 14 | $1.5 \times 10^{-2}$ | $3.7 \times 10^{-3}$ |
| | Slt | 1,545 | 3 | $9.3 \times 10^{-8}$ | $1.2 \times 10^{-7}$ |
| | Sh | 1,786 | 2 | I | I |
| | Ss, f | 1,792 | 14 | $1.1 \times 10^{-2}$ | $3.9 \times 10^{-3}$ |
| | Sh | 2,170 | 4 | $1.1 \times 10^{-8}$ | --- |
| | Slt | 2,265 | 2 | $2.0 \times 10^{-7}$ | $2.2 \times 10^{-6}$ |
| Star Point Sandstone | Ss, m | 2,466 | 17 | $3.1 \times 10^{-2}$ | $1.1 \times 10^{-2}$ |
| | Ss, m | 2,493 | 11 | $1.5 \times 10^{-2}$ | $6.6 \times 10^{-3}$ |



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Lines (1985) also reported the results of a constant-drawdown and recovery test conducted in a since-abandoned flowing well located in Straight Canyon (Section 4, Township 18 South, Range 6 East) approximately 2.5 miles east-southeast of the southeast corner of the proposed Tract 2 permit area. This well was located near the center of the Straight Canyon Syncline immediately east of the Joes Valley Fault in an area of suspected fracturing (Lines, 1985). The hydraulic conductivity of the Blackhawk-Star Point aquifer at this location (as determined from the measured transmissivity and the thickness) was calculated to be 1.6x10-1 foot per day, approximately one order of magnitude more permeable than the unfractured Blackhawk-Star Point aquifer as determined from previously mentioned laboratory and field tests. Lines (1985) attributed the relatively high value to fracturing.

In addition to the studies conducted by the U.S.G.S., PacifiCorp drilled and developed well TM-3 on September 28, 1993 to satisfy a special condition request from the mid-term permit review. Results of an aquifer test conducted April 28, 1994 can be found in Appendix 7. Well TM-3 was drilled in Straight Canyon, approximately 11 miles northwest of Orangeville, Utah (SW1/4 NW1/4 of Section 3, Plate 7-2). Well TM-3 was drilled to a total depth of 560 feet. At this location, the Star Point was encountered to a depth of 455 feet, with a transition from the Star Point - Spring Canyon Member to the Mancos Shale existing from a depth of 555 feet to 560 feet. The elevation of the ground surface at TM-3 is 6750 feet. Water in the Star Point Sandstone is under artisan pressure, with the static pressure on June 22, 1994 of 65 psi. Hence, the elevation of the potentiometric surface at TM-3 is 6900.2 feet. The transmissivity of the Star Point aquifer at this location (as determined from the measured permeability and the thickness) was calculated to be 2.46x10-2 foot per minute (or 35.4 feet per day), which is within the range of data collected by Lines (1985) . Piezometric data collected from TM-3 will be reported in the Annual Hydrologic Monitoring Report (see Appendix 7 for monitoring schedule and frequency).

No major fractures that might increase the permeability of the Blackhawk-Star Point aquifer are known to exist within the mine plan and adjacent areas (see Section 6.4.2). Thus, based on the remaining laboratory and field tests, this aquifer is assumed to have a hydraulic conductivity ranging from about 0.01 to 0.03 feet per day.

Data presented in the PAP (as developed initially by Lines, 1985 and modified using local data from the mine area) indicate that the flow of groundwater in the Blackhawk-Star Point aquifer is primarily to the south-southwest toward Straight Canyon. The hydraulic gradient within this aquifer varies in the eastern portion of the permit area from about 0.029 to 0.055 feet per foot, averaging 0.039 feet per foot. In the western portion of the permit area the hydraulic gradient ranges from about 0.046 to 0.061 feet per foot, averaging 0.048 feet per foot.

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2.1.2 Potential Dewatering Impacts. Potential inflows to underground workings at the Trail Mountain Mine were determined from modeling studies conducted by Lines (1985) using a three-dimensional finite-difference model developed by McDonald and Harbaugh (1984). Lines (1985) considered the mine inflow and drawdown estimates determined as a result of these modeling studies to be *more reliable than those that could be made with other more simplified analytical techniques*. In light of the fact that rigorous analytical techniques that apply to the local conditions are not

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available (Freeze and Cherry, 1979), the results of Lines' modeling efforts are considered adequate for inflow and drawdown estimation.

Lines assumed that the Blackhawk-Star Point aquifer could be simulated with three layers (two in the Blackhawk and one in the Star Point) and that the aquifer was isotropic and infinite in areal extent. Drawdown effects were modeled for various mine widths, mine lengths, premining hydraulic gradients, and hydraulic conductivities.

Figure 2-1 shows the effect of mine size on expected inflow rates as determined by Lines (1985). Results presented in this figure are based on hydraulic conductivities of 0.01 feet per day for the Blackhawk Formation and 0.02 feet per day for the Star Point Sandstone. These values are very similar to the laboratory hydraulic conductivities reported by Lines (1985) for sandstone units within the Blackhawk Formation and for the Star Point Sandstone, respectively. They are also similar to the hydraulic conductivities calculated in Section 2.1.1 for the Blackhawk-Star Point aquifer from transmissivity and thickness data reported by Lines (1985) from local aquifer tests. Thus, the results are considered representative of local conditions.

According to Figure 7-3 of the PAP, the projected mine workings will have a maximum length of 12,000 feet. Figure 2-2 was prepared from Figure 2-1 using this mine length, showing potential mine inflows for various mine widths and two premining hydraulic gradients.

Comparing Figure 7-3 of the PAP with Figure 7-1 of the PAP and Figure 5 of Lines (1985), the maximum width of the potentially saturated projected mine workings will be 12,000 feet. Utilizing a premining hydraulic gradient of 0.041 feet per foot as being most representative of local conditions, Figure 2-2 indicates a potential steady-state inflow of approximately 80 gallons per minute. Using a premining hydraulic gradient of 0.065 feet per foot to represent a worst case scenario, Figure 2.2 indicates a potential steady-state inflow of about 170 gallons per minute. Inflow rates are likely to be more near the lower end of the range except perhaps in the western portion of the permit area where hydraulic gradients are steeper and heads are greater.

If areas of significant fracturing are encountered in the saturated portion of the mine workings, inflows to the mine would increase; however, as noted previously, no significant fracturing that would result in increased inflows above the predicted range is known to exist in the mine area. Intercepted groundwater will be monitored, quantified and reported annually in the Hydrologic Monitoring Report.

Future mining within the Trail Mountain Mine (beyond Tract 2 LeaseUTU-64373) could conceivably extend approximately 8000 feet to the west of Tract 2 and 4000 feet south of tracts 1 and 2. Mining to the south should not significantly increase potential inflows to the mine workings since much of this area is unsaturated (based on a comparison of Figure 7-1 of the PAP with Figure 5 of Lines, 1985); however, mining to the west would continue into the saturated zone, thus increasing potential mine inflows. By extrapolation of the curves in Figure 2-2, increasing the width of the mine from 6000 to 14,000 feet should increase inflows by less than 25 gallons per minute under either premining hydraulic gradient condition.

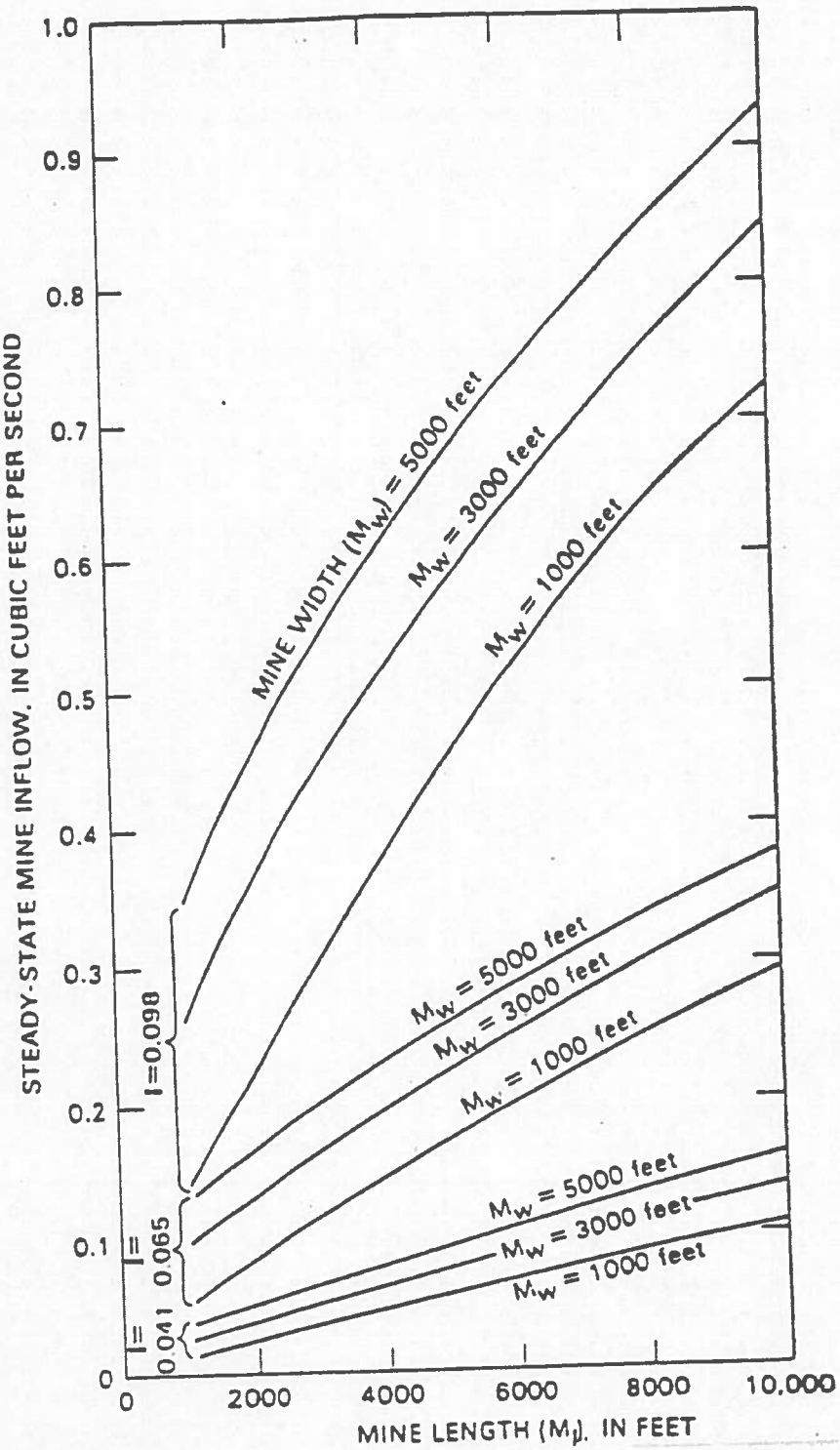


Figure 2-1. Effect of mine size and premining hydraulic gradient on mine inflow (from Lines, 1985).

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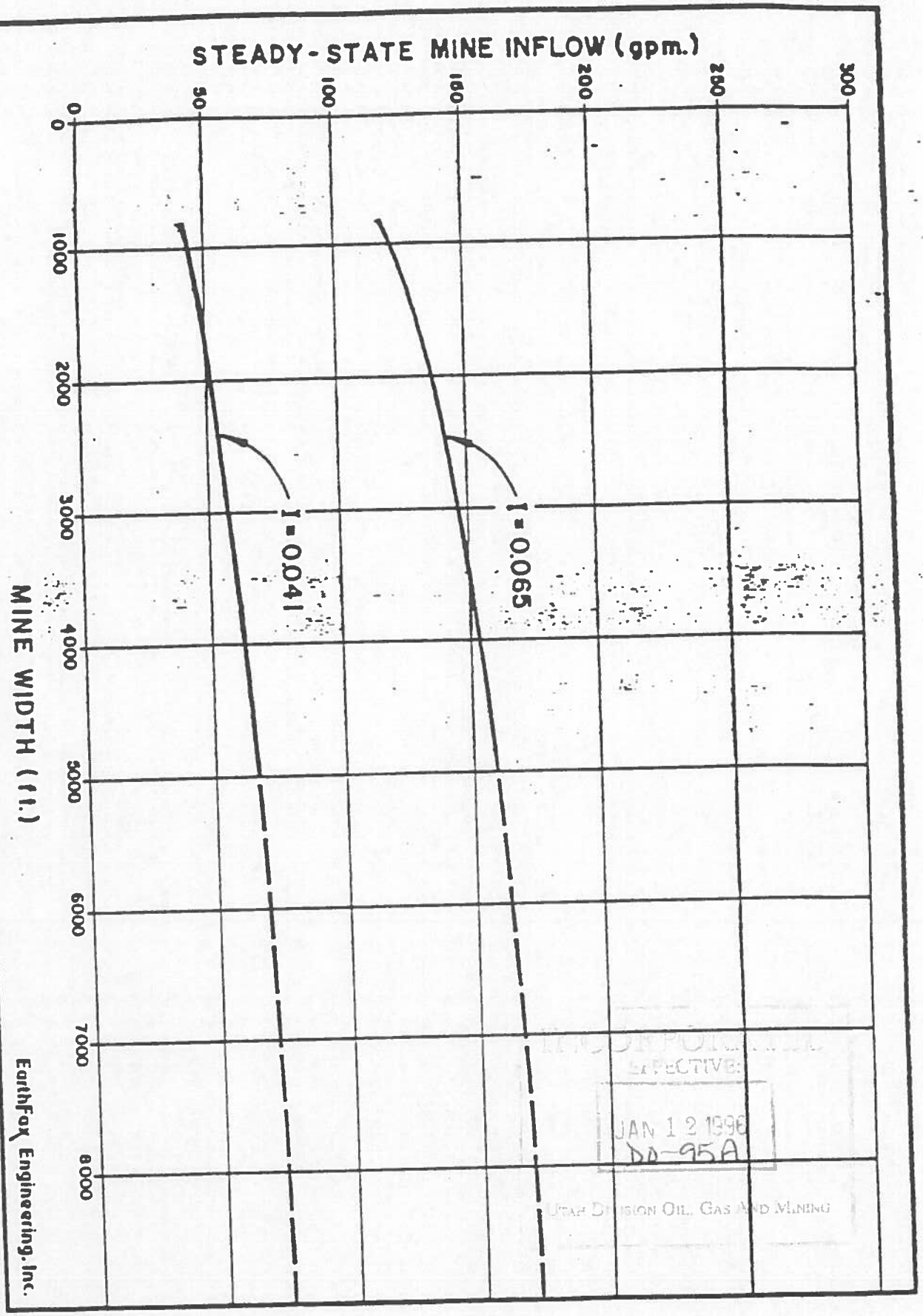


Figure 2-2. Effect of mine width on steady-state inflow for a mine length of 9000 ft.

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As noted in Section 7.1.3.2 of the PAP, in-mine water requirements are projected to amount to approximately 250 gallons per minute during mining operations. As a result, water that naturally flows into the mine workings will probably all be used underground except potentially when mine workings are concentrated near the western portion of the permit area. Thus, during most of the mining period, the need for pumping mine water to the surface will be eliminated. Similarly, the use of water that flows into the mine to satisfy underground requirements will preclude the need to pump that quantity of water from Cottonwood Creek.

Lines (1985) modeled potential drawdown due to mine dewatering for a hypothetical mine with a length of 10,000 feet, a width of 1000 feet, and a premining hydraulic gradient of 0.065 feet per foot. Curves developed from these modeling results are presented in Figure 203 for hydraulic conductivities of 0.01 and 0.02 feet per day for the Blackhawk Formation and Star Point Sandstone, respectively. Since the premining hydraulic gradient used to develop these curves is generally greater than the gradient in the mine area, the impacts predicted using these curves will be conservatively high.

Since the Trail Mountain Mine will be wider than 1000 feet, actual drawdowns near the center of the mine will be greater than predicted by Figure 2-3 (due to the law of superposition); however, the curves are reliable in predicting the maximum extent of drawdown effects near the mine since superposition does not affect the outer limit of the impact. Under a worst-case condition (i.e., all water encountered in the mine is pumped to the surface), data presented in Figure 2-3 indicate that, after 50 years of mining and accompanying dewatering (a probable maximum period of mining), the cone of depression resulting from dewatering can be expected to extend about two miles from the mine in the direction of the mine length (Dy) and five miles from the mine in the direction of the mine width (Dx). These effects will be most noticeable to the north and west of the mine since the Blackhawk Formation is typically unsaturated to the east and south.

Unless subsidence fractures extend vertically to overlying perched aquifers, inflow to the mine workings will be derived totally from the Blackhawk-Star Point aquifer. According to Lines (1985), only perched groundwater systems exist above the Blackhawk Formation. Thus, springs in overlying formations are not hydraulically connected to the Blackhawk and will not be impacted by mine inflows.

Data presented in Chapter 7 of the PAP (Appendix 7-1) and by Lines (1985) indicate that only three springs issue from the Blackhawk Formation within the zone of potential influence from dewatering. No other seeps or springs issuing from the Blackhawk Formation have been noted in the area adjacent to the mine plan area.

Spring TM-23 - Cottonwood Spring (discussed in the PAP) is located in the canyon bottom and is associated with the alluvial (glacial) deposits. With normal prepcitation, especially in the form of winter snowpack, runoff will saturate the alluvial deposits and a portion of groundwater would discharge at the location of Cottonwood Spring. During periods of drought, recharge to the alluvial deposits will be limited and the level of groundwater will be reduced to a point below the elevation of the Cottonwood Spring.

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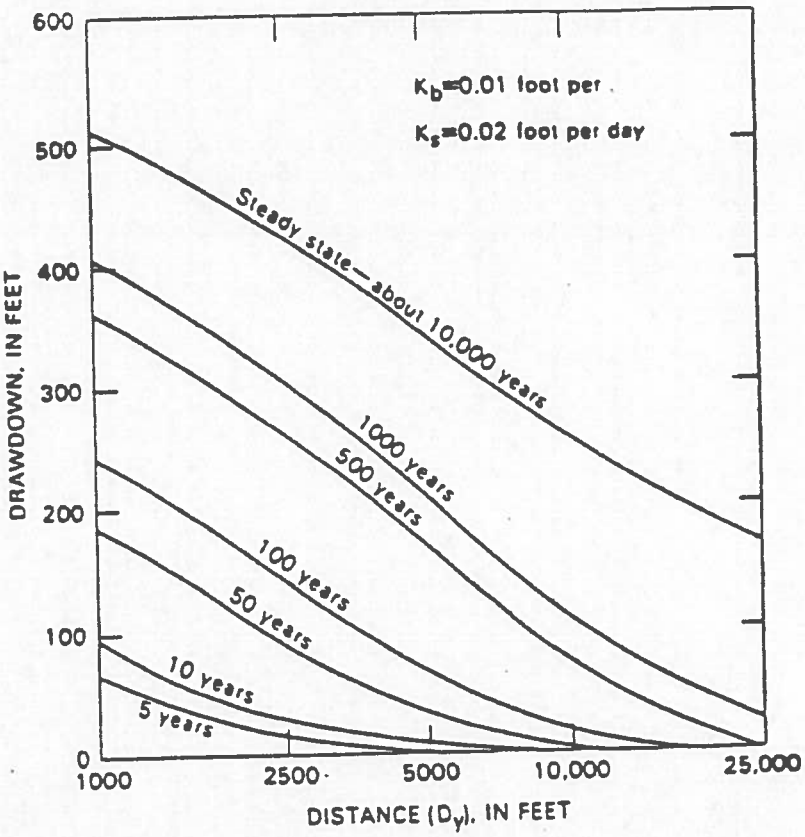


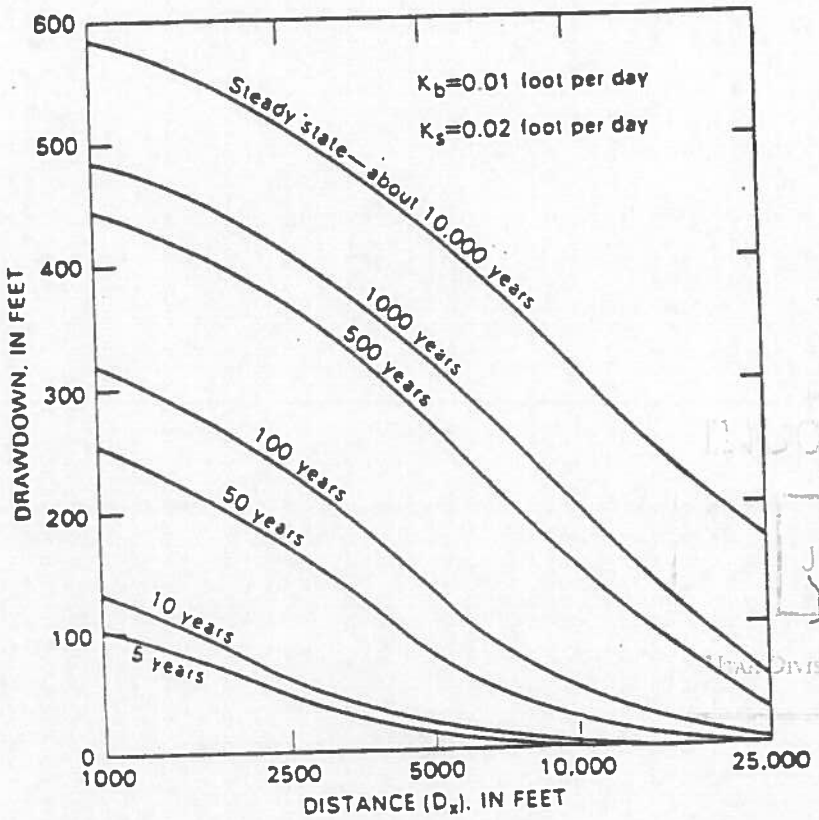


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Figure 2-3. Effect of mine size and time on drawdown in the Blackhawk-Satr Point aquifer (from Lines, 1985).

Springs (D-18-6) 4bbc-S1 and (D-18-6) 5abd-S1 (both discussed by Lines, 1985) issue in the bottom of Straight Canyon immediately downstream from Joes Valley Reservoir. These springs also contribute to the base flow of Cottonwood Creek via Straight Canyon. Lines (1985) reported that the flow of the former spring has been less than 2 gallons per minute during the period of observation. The latter spring had measured discharge rates of 180 and 200 gallons per minute during two observations in 1982. These two springs are located in the upper portion of the Blackhawk Formation approximately two miles west of the Trail Mountain permit boundary. It has been documented through surface exploration and mining within the Trail Mountain and surrounded areas that the saturated portion of the Star Point Sandstone is not directly connected to the upper portion of the Blackhawk Formation. PacifiCorp developed a water monitoring well (TM-3) in Straight Canyon just west of the mine permit boundary to evaluate hydrologic characteristics of the Star Point Sandstone. Similar to wells completed in Cottonwood Canyon, saturated strata was first encountered when the drilling penetrated the Spring Canyon member of the Star Point Sandstone (the upper portion of the Blackhawk Formation was unsaturated). Recharge to springs (D-18-6) 4bbc-S1 and (D-18-6) 5abd-S1 is thought to be controlled by fracture permeability associated with the Joe's Valley fault system.

The impacts associated with mining and dewatering of the intercepted groundwater in the Trail Mountain Mine will result in depressurzation of the Star Point Sandstone (monitoring of TM-3 in Straight Canyon will verify the amount of depressurzation). Prior to mining, the elevation of the potentiometric level in TM-3 was 6900 feet. The top of the Spring Canyon Member of the Star Point Sandstone is exposed in Straight Canyon 1.7 miles southeast of TM-3 at an elevation of 6500 feet. Because the Spring Canyon Member outcrops below the potentiometric level reflected by TM-3, there is a hydrodynamic potential for the water to discharge from the Spring Canyon Member to Straight Canyon. However, we believe that very little, if any , groundwater discharges to Straight Canyon from this horizon and therefore depressurzation of the Spring Canyon Member will not decrease the flow in Straight Canyon. Two lines of evidence support this conclusion. First, natural groundwater discharge would be indicated by springs in the Spring Canyon Member, however no springs have been identified in this unit in vicinity of Straight Canyon. Second, we have calculated a maximum potential discharge of 1 gallon per minute based on the assumptions described below. This discharge rate was calculated using Darcy's law:

$$Q = K I A,$$

where,

Q = discharge rate
K = hydraulic conductivity
I = gradient
A = cross sectional area.

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PacifiCorp calculated a hydraulic conductivity of $4.3 \times 10^{-6}$ feet $sec^{-1}$ for the Spring Canyon Member from a recovery test conducted on well TM-3. A gradient of 0.05 was calculated from the difference between the pre-mining elevation of the potentiometric level in TM-3 (6900 feet) and the outcrop elevation of the Spring Canyon Member in Straight Canyon (6450 feet) divided by the distance

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separating these two points (9000 feet). A cross sectional area of 10,000 $ft^2$ was calculated using the thickness of the Spring Canyon Member (100 feet) and a 100-foot exposure width.

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2.1.3 Potential Subsidence Impacts. The maximum area of the potential surface expression of subsidence due to mining in the is presented in Figure 7-1 of the PAP. Nine springs exist within this area. Data presented in Appendix 7-1 of the PAP documents the geologic occurrence of each spring. All of the springs emanate from the North Horn Formation except T-14 (17-25-1) which issues from the Price River Formation.

Springs within and surrounding the mine plan area were inventoried in June, 1981 and October 1985. Experience gained from the data collected at nearby mines and from the general area has provided vital information regarding the possible effect of mining on springs.

Plate 7-1 shows the location of all water sources found during the hydrologic inventory of the mine plan and adjacent area. As shown, only a limited number of springs/seeps was found on the east face of Trail Mountain. The springs located were mainly confined to the west slopes of the mountain. Based on the data collected by PacifiCorp (Volume 9 Hydrologic Section, East Mountain Permit Area) and the Bureau of Mines (IC 9405 Response of Springs to Longwall Coal Mining at the Deer Creek and Cottonwood Mines, Wasatch Plateau, UT) on the adjacent East Mountain property, mining induced impacts have not been identified. As discussed in Chapter 11, subsidence is expected to have no impact on bedrock-aquifer springs in the vicinity of the Trail Mountain Mine.

As was previously discussed, no significant impacts to the groundwater system are expected from the mining operation. The groundwater monitoring plan (discussed in Chapter 7) will provide a means to follow the possible effect of the mining activities on the groundwater system.

Any roads, fences, stock ponds, earth dams, or water troughs which are materially damaged by subsidence will be repaired and regraded to restore them to their pre-subsidence usefulness. Should significant subsidence impacts occur, the applicant will restore, to the extent technologically and economically feasible, those surface lands that were reduced in reasonably foreseeable use as a result of such subsidence to a condition capable of supporting reasonable foreseeable uses that such lands were capable of supporting before subsidence.

In order to restore any land affected by Applicant's mining operations to a condition capable of supporting the current and postmining land uses stated herein, the Applicant will replace water determined to have been lost or adversely affected as a result of Applicant's mining operations if such loss or adverse impact occurs prior to final bond release. The water will be replaced from an alternative source in sufficient quantity and quality to maintain the current and postmining land uses as stated herein.

During the course of regular monitoring activities required by the permit, or as the Applicant otherwise acquires knowledge, the Applicant will advise the Division of the loss or adverse occurrence discussed above, within ten working days of having determined that it has occurred. Within ten days after the Division notifies Applicant, in writing, that it has determined that the water loss is the result of the Applicant's mining operation, the Applicant will meet with the Division to determine if a plan for replacement is necessary and, if so, establish a schedule for submittal of a

plan to replace the affected water. Upon acceptance of the plan by the Division, the plan shall be implemented. Applicant reserves the right to appeal the Division's water loss determinations as well as the proposed plan and schedule for water replacement as provided by Utah Code Ann. 40-10-22(3)(a).

According to data presented by Lines (1985), water quality is similar in all aquifers in the Trail Mountain area. Thus, subsidence should not degrade the quality of groundwater. Some improvement of groundwater quality may even occur since flow rates through the bedrock would increase and residence time in the bedrock would decrease, thereby decreasing dissolution and lowering the dissolved concentrations of various constituents below current concentrations.

## 2.2 Groundwater Monitoring Plan

A groundwater monitoring plan has been developed for the Trail Mountain permit area and adjacent areas which includes monitoring of selected springs, in-mine sources and monitoring wells. Details of this plan can be found in Appendix 7-1 of the PAP.

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# 3.0 SURFACE WATER

## 3.1 Probable Impacts

3.1.1 Background Information. According to Chapter 7 of the PAP the Trail Mountain Mine is located within the Cottonwood Creek watershed. Cottonwood Creek has had an average annual flow of 70,700 acre feet, approximately 60 percent of which occurs as snowmelt runoff during May through July . The quality of water in Cottonwood Creek is good near the mine with total dissolved solids concentrations generally less than 400 milligrams per liter.

The permit area is drained entirely by ephemeral and intermittent streams. Watersheds tend to be steep and well vegetated.

3.1.2 Potential Water Quality Impacts. Existing runoff and sediment control facilities were designed in accordance with applicable Division regulations and are maintained to minimize sediment concentrations from the surface facilities to Cottonwood Creek.

3.1.3 Potential Water Quantity Impacts. Water for in-mine use is from underground sources. As the mine workings expand to the west (into the saturated zone), intercepted water in excess of mine requirements will either be stored in sealed areas or discharged according to the stipulations listed in the UPDES permit (see Appendix 7-11).

Projected in-mine water requirements are 250 gallons per minute when the mine is fully developed. Assuming a 195-day work year, this quantity amounts to approximately 180 acre feet per year and represents 0.2 percent of the average annual flow of Cottonwood Creek. A reduction in the flow of the stream would decrease the amount of water available for downstream irrigation, stock watering, and wildlife usage.

## 3.2 Surface Water Monitoring Plan

A surface water monitoring plan has been previously submitted to the Division by PacifiCorp. Details of this plan can be found in Appendix 7 of the PAP.

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# 4.0 CONCLUSIONS

The following conclusions have been presented in this document in relation to potential hydrologic impacts from mining at the Trail Mountain Mine.

- Inflow of water to the underground workings at the Trail Canyon Mine are expected to range between 80 and 170 gallons per minute. Inflows are predicted to be lowest in the eastern portion of the mine and highest to the west, where hydraulic gradients are steeper and heads are greater. Inflow to the mine workings will be derived primarily from the Blackhawk Formation.

- Expansion of the mine workings into Lease UTU-64375 would increase inflows to the mine by less than 10 gallons per minute.

- Most water encountered underground will be used underground during mining.

- The cone of depression resulting from mine dewatering will extend a maximum of two miles north and south of the mine and five miles east and west of the mine. The effects will be most noticeable to the north and west where the bedrock is saturated.

- The primary potential impact due to a drawdown of the potentiometric surface near the mine is a decrease in the base flow of Cottonwood Creek. The maximum potential decrease in the average annual flow of Cottonwood Creek near Orangeville is 0.2 to 0.4 percent.

- Due to the limited number of springs in the immediate vicinity of the mine, subsidence is predicted to have little impact on local spring flow.

- No adverse impacts to surface or groundwater quality are anticipated as a result of mining at the Trail Mountain Mine.

- Water for in-mine use is from underground sources. As the mine workings expand to the west (into the saturated zone), intercepted water in excess of mine requirements will either be stored in sealed areas or discharged according to the stipulations listed in the UPDES permit Projected in-mine water requirements are 250 gallons per minute when the mine is fully developed. Assuming a 195-day work year, this quantity amounts to approximately 180 acre feet per year and represents 0.2 percent of the average annual flow of Cottonwood Creek.

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APPENDIX 7-11

UPDES PERMIT (HISTORIC)

**APPENDIX 7-11**

**UPDES PERMIT**

AMENDMENT 10

APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining

by TM date 8/13/90

Mining
DOCUMENT NO. 1610k

Permit No.: UTG040003

**STATE OF UTAH**
**DEPARTMENT OF HEALTH**
**BUREAU OF WATER POLLUTION CONTROL**
**P.O. BOX - 16690**
**SALT LAKE CITY, UTAH 84116-0690**

***Authorization to Discharge Under the***

***Utah Pollutant Discharge Elimination System***

***Utah General Permit for Coal Mining***

In compliance with provisions of the Utah Water Pollution Control Act, Title 26 Chapter 11 Utah Code Annotated, 1953 as amended, the Act. The coal company identified in the application is authorized to discharge to Waters of the State as identified in the application in accordance with discharge point(s), effluent limitations, monitoring requirements and other conditions set forth herein.

This general permit shall become effective on May 4, 1989

This general permit and the authorization to discharge shall expire at midnight, April 30, 1993.

Signed this 4th day of May 1989

Authorized Permitting Official
Executive Secretary
Water Pollution Control Committee

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# I. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

## A. Definitions.

1. The "30-day (and monthly) average", is the arithmetic average of all samples collected during a consecutive 30-day period or calendar month, whichever is applicable. The calendar month shall be used for purposes of reporting self-monitoring data on discharge monitoring report forms.

2. The "7-day (and weekly) average", is the arithmetic average of all samples collected during a consecutive 7-day period or calendar week, whichever is applicable. The 7-day and weekly averages are applicable only to those effluent characteristics for which there are 7-day average effluent limitations. The calendar week which begins on Sunday and ends on Saturday, shall be used for purposes of reporting self-monitoring data on discharge monitoring report forms. Weekly averages shall be calculated for all calendar weeks with Saturdays in the month. If a calendar week overlaps two months (i.e., the Sunday is in one month and the Saturday in the following month), the weekly average calculated for that calendar week shall be included in the data for the month that contains the Saturday.

3. "Daily Maximum" ("Daily Max.") is the maximum value allowable in any single sample or instantaneous measurement.

4. "Composite samples" shall be flow proportioned. The composite sample shall, as a minimum, contain at least four (4) samples collected over the compositing period. Unless otherwise specified, the time between the collection of the first sample and the last sample shall not be less than six (6) hours nor more than 24 hours. Acceptable methods for preparation of composite samples are as follows:

   a. Constant time interval between samples, sample volume proportional to flow rate at time of sampling;

   b. Constant time interval between samples, sample volume proportional to total flow (volume) since last sample. For the first sample, the flow rate at the time the sample was collected may be used;

   c. Constant sample volume, time interval between samples proportional to flow (i.e., sample taken every "X" gallons of flow); and,

   d. Continuous collection of sample, with sample collection rate proportional to flow rate.

5. A "grab" sample, for monitoring requirements, is defined as a single "dip and take" sample collected at a representative point in the discharge stream.

6. An "instantaneous" measurement, for monitoring requirements, is defined as a single reading, observation, or measurement.

7. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

8. "Bypass" means the diversion of waste streams from any portion of a treatment facility.

9. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

10. "Executive Secretary" means Executive Secretary of the Utah Water Pollution Control Committee.

11. "EPA" means the United States Environmental Protection Agency.

12. The term "10-year, 24-hour precipitation event" shall mean the maximum 24-hour precipitation event with a probable recurrence interval of once in 10 years as defined by the National Weather Service and Technical Paper No. 40, **Rainfall Frequency Atlas of the U.S.**, May 1961, and subsequent amendments or equivalent regional or rainfall probability information developed therefrom.

13. "Active mining area" means the areas on and beneath land used or disturbed in activity related to the extraction, removal, or recovery of coal from its natural deposits. This term excludes coal preparation plants, coal preparation plant associated areas and post-mining areas.

14. "Reclamation area" means the surface area of a coal mine which has been returned to required contour and on which revegetation (specifically, seeding or planting) work has commenced.

15. The term "coal preparation plant" means a facility where coal is crushed, screened, sized, cleaned, dried, or otherwise prepared and loaded for transit to a consuming facility.

16. The term "coal preparation plant associated areas" means the coal preparation plant yards, immediate access roads, coal refuse piles, and coal storage piles and facilities.

17. The term "settleable solids" is that matter measured by the volumetric method specified below:

The following procedure is used to determine settleable solids:

Fill an Imhoff cone to the one-liter mark with a thoroughly mixed sample. Allow to settle undisturbed for 45 minutes. Gently stir along the inside surface of the cone with a stirring rod. Allow to settle undisturbed for 15 minutes longer. Record the volume of settled material in the cone as milliliters per liter. Where a separation of settleable and floating material occurs, do not include the floating material in the reading.

18. Mine drainage means any drainage, and any water pumped or syphoned, from an active mining area or a post mining area.

19. Alkaline mine drainage means mine drainage which before any treatment has a pH equal to or greater than 6.0 and total iron concentration less then 10 mg/l.

20. Post mining areas means: 1) a reclamation area or 2) the underground workings of an underground coal mine after extraction removal or recovery of coal from its natural deposit has ceased and prior to bond release.

B. Criteria for Inclusion in The General Permit for Coal Mining.

This General permit shall apply only to the discharge of treated wastewater from:

Coal mining operations either new or existing in Utah which include or will include in part or in whole alkaline mine water drainage, storm water runoff from coal preparation plant associated areas, active mining areas, and post mining areas. The total amount of total dissolved solids discharged from all mine water and decant operations is limited to one ton per day.

C. Notice of Intent for a General Permit for Coal Mining.

1. Any facility which desires a general permit for coal mining and meets the requirement of B. above can be issued a general permit only by following the procedures listed below.

   Submit a Notice of Intent (NOI) to obtain a general permit for coal mining. The NOI shall include the following items:

   a. Name of the facility.

   b. Facility contact person and phone number for that person.

   c. The facility mailing address (include zip code).

   d. Complete items e through q of the NOI if the information contained in those items has not already been submitted in a previous NOI or individual UPDES application, or if circumstances have changed such that the information previously submitted would be out of date or incorrect.

   e. Facility location such as street address, county, city or town, state and zip code. Include the latitude and longitude of the facility to the nearest 15 seconds.

f. Name of the operator if other than the owner. Indicate here if the owner will be the operator and the phone number where the operator can be reached during normal and off work hours, and the address of the operator.

g. Statement as to whether the facility or any existing or proposed discharge points are located on Indian lands or within National Forest boundaries.

h. List of any other permits (including other UPDES permits) that the facility has or is attempting to obtain such as UIC or RCRA.

i. Statements as to whether the facility has any hazardous waste treatment storage or disposal areas.

j. List location and identification number (such as 001, 002, etc.) of each existing discharge and/or proposed discharge point(s). This includes the latitude and longitude to the nearest 15 seconds and the name of the receiving water(s).

k. A description of the source of the wastewater for each discharge point.

l. A description of the treatment given or proposed for the wastewater at each discharge point and if necessary a justification of why no treatment is required.

m. Indicate for each discharge point flow characteristics such as whether flow is or will be continuous or intermittent and indicate projected and/or actual average and maximum flows in gpd.

n. For each discharge point submit data for the following parameters:

1) Biochemical oxygen demand (BOD)
2) Chemical oxygen demand (COD)
3) Total organic carbon (TOC)
4) Total suspended solids (TSS)
5) Flow
6) Ammonia (as N)
7) Oil and grease
8) Temperature
9) pH
10) Total dissolved solids (TDS)
11) Total iron
12) Date and time of sampling for each parameter
13) Date and time of analysis for each parameter
14) Laboratory which has completed the analysis for each parameter

If no data is available, indicate why the data is not available.

The Executive Secretary may waive the reporting requirements for any of these pollutants and parameters if the applicant submits a request for such a waiver before or with the NOI which demonstrates that information adequate to support issuance of the permit can be obtained through less stringent reporting requirements.

o. Indicate for each discharge point the presence or absence of any toxic and/or priority pollutants as listed by EPA in 40 CFR Part 403.

p. Area Maps (Active Mining Operations)

Facilities are required to submit an Area Map in the form specified hereafter.

The Area Map(s) and any necessary revised Area Map(s) shall be submitted in the form specified below and shall be made from USGS topographical maps (7.5 or 15-minute series) or other appropriate sources as approved by the Executive Secretary or his designee. Each revised area map shall be 8 1/2 inches by 11 inches and shall be in black and white suitable to produce readable copies by rapid printing methods. (Xerox, Dennison, Offset printing, etc.) or as approved by the Executive Secretary. Where additional 8 1/2 inch by 11 inch maps are required to show the area of operation, they shall be numbered and a key shall be shown on the first map. The first map section shall have the company name, mine/job name, address, and UPDES number clearly printed thereon. Also, one line of latitude and one line of longitude shall be marked on each map section. The Area Map(s) shall delineate the following, using the graphics as indicated:

1. Existing area of operation shall be outlined by a solid line and the map shall show areas at least one mile beyond the existing areas of operation. _____

2, Existing point source(s) (Solid Triangle)

3. The projected area of operation for the next five years --------- (Dashed Outline)

4. Projected point source(s) for the next five years (Opened Triangle)

5. The active-inactive status of all discharge points which are listed in the application. These discharge points shall be assigned numbers 001, 002, 003, etc.

6. The location of springs, rivers and other surface water bodies.

7. The location of any hazardous waste treatment, storage and disposal areas, and where any fluids are injected into the ground.

q. If there are any changes corrections, or other modifications or adjustments of the location of the point source discharges, the permittee shall submit a revised Area Map(s) as described in p. above. Such maps must be submitted 30 days prior to commencement of the discharge.

r. The NOI must be signed by a responsible official of the company with the following format:

> I certify under penalty of law that I have personally examined and am familiar with the information submitted in the application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the NOI application, I believe the information is true, accurate and correct. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.
>
> _____ _____ _____
> Name and Official Title Signature Date

2. Additional information or clarification of information submitted in the NOI may be requested by the Executive Secretary.

3. The NOI to obtain a General Permit for Coal Mining shall be submitted 180 days before expiration of the general permit or an individual permit, for all facilities desiring to continue or obtain a general permit; with the exception of those facilities that have submitted an NOI within one year of the expiration date of the general permit need not resubmit another NOI.

4. New facilities must submit a NOI at least 180 days before the beginning date of discharge.

5. The Executive Secretary will respond to the submission of the NOI by reviewing the NOI within 30 days for a UPDES new source or discharger and 60 days for an existing source and notifying the permittee whether more information is needed or if the NOI is complete, issue the general permit.

D. Specific Limitations and Self-Monitoring Requirements.

1. During the period beginning immediately and lasting through the duration of this permit, the permittee is authorized to discharge from all point sources associated with active mining operations indicated on the Area Maps submitted and approved pursuant to Part I. C. 1p. Such discharges shall be limited and monitored by the permittee as specified below:

| Effluent Characteristics | Discharge Limitations a/ Average 30-day | 7-Day | Daily Maximum | Monitoring Requirements Measurement Frequency | Sample Type |
|---|---|---|---|---|---|
| Flow, gpd | N/A | N/A | N/A | Monthly | Measured b/ |
| Suspended Solids, mg/L | 25 | 35 | 70 | Monthly | Grab |
| Total Iron, mg/L | N/A | N/A | 2.0 | Monthly | Grab |
| Dissolved Solids, lbs/day | N/A | N/A | N/A c/ | Monthly | Grab |
| Oil Grease, mg/L | N/A | N/A | 10 | Monthly | Grab |

The pH shall not be less than 6.5 standard units nor greater than 9.0 standard units and shall be monitored twice per month by a grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

There shall be no discharge of sanitary wastes or any process water from coal preparation plants.

a/ See Definitions, Part I. A. for definition of terms.

b/ For the intermittent discharges, the duration of the discharge shall be reported along with the flow.

c/ The total amount of Total Dissolved Solids (TDS) discharged from all mine water and decant operations is limited to one ton (2,000 pounds) per day.

2. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at any point which is representative of each discharge prior to its mixing with the receiving stream and as indicated by the solid triangles on the current Area Maps submitted pursuant to part I. C. 1p.

3. Any overflow, increase in volume of a discharge or discharge from a bypass system caused by precipitation within a 24-hour period less than or equal to the 10-year, 24-hour precipitation event (or snowmelt of equivalent volume) at any outfall may comply with the following limitation instead of the Total Suspended Solids limitations contained in Part I. D. 1. provided the facility has been designed, constructed and operated to adequately treat up to a 10 year 24 hour storm event:

| Effluent Characteristic | Daily Maximum |
|---|---|
| Settleable Solids | 0.5 ml/L |

In addition to the monitoring requirements specified under Part I. D. 1., all effluent samples collected during storm water discharge events shall also be analyzed for settleable solids. Such analyses shall be conducted on grab samples.

4. Any overflow, increase in volume of a discharge or discharge from a bypass system caused by precipitation within a 24-hour period greater than the 10-year, 24-hour precipitation event (or snowmelt of equivalent volume) at any outfall may comply with the following limitations instead of the otherwise applicable limitations:

   The pH shall not be less than 6.5 standard units nor greater than 9.0 standard units. However, as stated under Part I. D. 3., all effluent samples collected at any outfall during storm water discharge events shall be analyzed for settleable solids and the parameters identified under Part I. D. 1.

5. The operator shall have the burden of proof that the discharge or increase in discharge was caused by the applicable precipitation event described in Parts I. D. 3. and D. 4. The alternate limitations in Parts I. D. 3. and D. 4. shall not apply to treatment systems that treat underground mine water only.

6. Best Management Practices. The company shall implement and maintain best management practices for the control of road salt storage and dust suppressent runoff and for the prevention of the discharge of process water from coal preparation plants. In addition the facility must minimize the discharge of salt by using the largest practical amount of saline water for process and dust control.

## II. MONITORING, RECORDING AND REPORTING REQUIREMENTS

A. Representative Sampling. Samples taken in compliance with the monitoring requirements established under Part I shall be collected from the effluent stream prior to discharge into the receiving waters. Samples and measurements shall be representative of the volume and nature of the monitored discharge.

B. Monitoring Procedures. Monitoring must be conducted according to test procedures approved under Utah Administrative Code (UAC) Section R448-2-10, unless other test procedures have been specified in this permit.

C. Penalties for Tampering. The Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six months per violation, or by both.

D. Reporting of Monitoring Results. Monitoring results obtained during the previous calendar quarter shall be summarized for each calendar month on separate Discharge Monitoring Report Forms (DMR, EPA No. 3320-1). All three DMRs for the calendar quarter shall be postmarked no later than the 28th day of the calendar month following the completed reporting period. If no discharge occurs during the reporting period, "no discharge" shall be reported. Legible copies of these, and all other reports required herein, shall be signed and certified in accordance with the requirements of Signatory Requirements (see Part IV), and submitted to the Utah Bureau of Water Pollution Control and to EPA at the following addresses:

Original to:
Utah Department of Health
Bureau of Water Pollution Control
288 North 1460 West
P.O. Box 16690
Salt Lake City, Utah 84116-0690
Attention: Compliance and Monitoring Program

Copy to:
United States Environmental Protection Agency
Region VIII
Denver Place
999 18th Street, Suite 500
Denver, Colorado 80202-2405
Attention: Water Management Division
Compliance Branch (8WM-C)

E. Compliance Schedules. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any Compliance Schedule of this permit shall be submitted no later than 14 days following each schedule date.

F. Additional Monitoring by the Permittee. If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under UAC Section R448-2-10 as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR. Such increased frequency shall also be indicated.

G. Records Contents. Records of monitoring information shall include:
1. The date, exact place, and time of sampling or measurements:
2. The individual(s) who performed the sampling or measurements;
3. The date(s) and time(s) analyses were performed;
4. The individual(s) who performed the analyses;
5. The analytical techniques or methods used; and,
6. The results of such analyses.

H. Retention of Records. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least three years from the date of the sample, measurement, report or application. This period may be extended by request of the Executive Secretary at any time. Data collected on site, copies of Discharge Monitoring Reports, and a copy of this UPDES permit must be maintained on site during the duration of activity at the permitted location.

I. Twenty-four Hour Notice of Noncompliance Reporting.

1. The permittee shall (orally) report any noncompliance which may seriously endanger health or the environment as soon as possible, but no later than twenty-four (24) hours from the time the permittee first became aware of the circumstances. The report shall be made to the Utah Bureau of Water Pollution Control, (801) 538-6146, or 24 hour answering service (801) 538-6333.

2. The following occurrences of noncompliance shall be reported by telephone to the Utah Bureau of Water Pollution Control, Compliance and Monitoring Branch at (801) 538-6146 by the first workday (8:00 a.m. - 5:00 p.m. Mountain Time) following the day the permittee became aware of the circumstances:

   a. Any unanticipated bypass which exceeds any effluent limitation in the permit (See Part III. G., Bypass of Treatment Facilities.);

   b. Any upset which exceeds any effluent limitation in the permit (See Part III. H., Upset Conditions.); or,

   c. Violation of a maximum daily discharge limitation for any of the pollutants listed in the permit.

3. A written submission shall also be provided within five days of the time that the permittee becomes aware of the circumstances. The written submission shall contain:

   a. A description of the noncompliance and its cause;

   b. The period of noncompliance, including exact dates and times;

   c. The estimated time noncompliance is expected to continue if it has not been corrected; and,

d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

e. Steps taken, if any, to mitigate the adverse impacts on the environment and human health during the noncompliance period.

4. The Executive Secretary may waive the written report on a case-by-case basis if the oral report has been received within 24 hours by the Compliance and Monitoring Branch, Utah Bureau of Water Pollution Control, (801) 538-6146.

5. Reports shall be submitted to the addresses in Part II. D., Reporting of Monitoring Results.

J. Other Noncompliance Reporting. Instances of noncompliance not required to be reported within 24 hours shall be reported at the time that monitoring reports for Part II. D. are submitted. The reports shall contain the information listed in Part II. I. 3.

K. Inspection and Entry. The permittee shall allow the Executive Secretary, or an authorized representative, or EPA upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of the permit;

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and,

4. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Act, any substances or parameters at any location.

## III. COMPLIANCE RESPONSIBILITIES

A. Duty to Comply. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application. The permittee shall give advance notice to the Executive Secretary of the Water Pollution Control Committee of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

B. Penalties for Violations of Permit Conditions. The Act provides that any person who violates a permit condition implementing provisions of the Act is subject to a civil penalty not to exceed $10,000 per day of such violation. Any person who willfully or negligently violates permit conditions is subject to a fine not exceeding $25,000 per day of violation. Any person convicted under Section 26-11-16(2) of the Act a second time shall be punished by a fine not exceeding $50,000 per day. Except as provided in permit conditions on Part III, G., Bypass of Treatment Facilities and Part III, H., Upset Conditions, nothing in this permit shall be construed to relieve the permittee of the civil or criminal penalties for noncompliance.

C. Need to Halt or Reduce Activity not a Defense. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

D. Duty to Mitigate. The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

E. Proper Operation and Maintenance. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.

F. Removed Substances. Collected screenings, grit, solids, sludges, or other pollutants removed in the course of treatment shall be buried or disposed of in such a manner so as to prevent any pollutant from entering any waters of the state or creating a health hazard. Sludge/digestor supernatant and filter backwash shall not directly enter either the final effluent or waters of the state.

G. Bypass of Treatment Facilities.

1. Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs 2 and 3 of this section. Return of removed substances, as described in Part III. F., to the discharge stream shall not be considered a bypass under the provisions of this paragraph.

2. Notice:

a. Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least 60 days before the date of the bypass.

b. Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required under Part II. J., Twenty-four Hour Reporting.

3. Prohibition of bypass.

a. Bypass is prohibited and the Executive Secretary may take enforcement action against a permittee for a bypass, unless:

(1) The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage ;

(2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and,

(3) The permittee submitted notices as required under paragraph 2 of this section.

b. The Executive Secretary may approve an anticipated bypass, after considering its adverse effects, if the Executive Secretary determines that it will meet the three conditions listed above in paragraph 3. a. of this section.

H. Upset Conditions.

1. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with technology based permit effluent limitations if the requirements of paragraph 2 of this section are met. The Executive Secretary's administrative determination regarding a claim of upset cannot be judiciously challenged by the permittee until such time as an action is taken for noncompliance.

2. Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

   a. An upset occurred and that the permittee can identify the cause(s) of the upset;

   b. The permitted facility was at the time being properly operated;

   c. The permittee submitted notice of the upset as required under Part II. L. Twenty-four Hour Notice of Noncompliance Reporting; and,

   d. The permittee complied with any remedial measures required under Part III. D., Duty to Mitigate.

3. Burden of proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

I. Toxic Pollutants. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Federal Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

J. Changes in Discharge of Toxic Substances. Notification shall be provided to the Executive Secretary as soon as the permittee knows of, or has reason to believe:

1. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

   a. One hundred micrograms per liter (100 ug/L);

   b. Two hundred micrograms per liter (200 ug/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/L) for 2,4-dinitrophenol and for 2-methyl-4, 6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;

   c. Five (5) times the maximum concentration value reported for that pollutant in the permit application in accordance with UAC Section R448-8-3.4 (7) or (10); or,

   d. The level established by the Executive Secretary in accordance with UAC Section R448-8-4.2 (6).

2. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

a. Five hundred micrograms per liter (500 ug/L);

b. One milligram per liter (1 mg/L) for antimony:

c. Ten (10) times the maximum concentration value reported for that pollutant in the permit application in accordance with UAC Section R448-8-3.4(9); or,

d. The level established by the Executive Secretary in accordance with UAC Section R448-8-4.2(6).

## IV. GENERAL REQUIREMENTS

A. Planned Changes. The permittee shall give notice to the Executive Secretary as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

1. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source as defined in UAC Section R448-8-1.5.; or,

2. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements under Part IV. A. 2.

B. Anticipated Noncompliance. The permittee shall give advance notice of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

C. Permit Actions. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

D. Duty to Reapply. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application should be submitted at least 180 days before the expiration date of this permit.

E. Duty to Provide Information. The permittee shall furnish to the Executive Secretary, within a reasonable time, any information which the Executive Secretary may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Executive Secretary, upon request, copies of records required to be kept by this permit.

F. Other Information. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Executive Secretary, it shall promptly submit such facts or information.

G. Signatory Requirements. All applications, reports or information submitted to the Executive Secretary shall be signed and certified.

1. All permit applications shall be signed as follows:

a. For a corporation: by a responsible corporate officer;

b. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively;

c. For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official.

2. All reports required by the permit and other information requested by the Executive Secretary shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

   a. The authorization is made in writing by a person described above and submitted to the Executive Secretary, and,

   b. The authorization specified either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

3. Changes to authorization. If an authorization under paragraph IV. G. 2. is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph IV. G. 2. must be submitted to the Executive Secretary prior to or together with any reports, information, or applications to be signed by an authorized representative.

4. Certification. Any person signing a document under this section shall make the following certification:

   "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

H. Penalties for Falsification of Reports. The Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six months per violation, or by both.

I. Availability of Reports. Except for data determined to be confidential under UAC Section R448-8-3.2, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Executive Secretary. As required by the Act, permit applications, permits and effluent data shall not be considered confidential.

J. Oil and Hazardous Substance Liability. Nothing in this permit shall be construed to preclude the permittee of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Federal Clean Water Act or the Utah Water Pollution Control Act.

K. Property Rights. The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

L. Severability. The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

M. Transfers. This permit may be automatically transferred to a new permittee if:

1. The current permittee notifies the Executive Secretary at least 30 days in advance of the proposed transfer date;

2. The notice includes a written agreement between the existing and new permittee containing a specific date for transfer of permit responsibility, coverage, and liability between them; and,

3. The Executive Secretary does not notify the existing permittee and the proposed new permittee of his or her intent to modify, or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in paragraph 2 above.

N. State Laws. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by Section 26-11-19 of the Act.

O. Water Quality Standard Requirement - Reopener Provision
This permit may be reopened and modified (following proper administrative procedures) to include the appropriate effluent limitations and compliance schedule, if necessary, if one or more of the following events occurs:

1. Water Quality Standards for the receiving water(s) to which the permittee discharges are modified in such a manner as to require different effluent limits than contained in this permit.

2. A final wasteload allocation is developed and approved by the State and/or EPA for incorporation in this permit.

3. A revision to the current 208 plan is approved and adopted which calls for different effluent limitations than contained in this permit.

1610k

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

APPENDIX 7-12

MACROINVERTEBRATE STUDY

# APPENDIX 7-12

# MACROINVERTEBRATE STUDY (COTTONWOOD CREEK)

Interim Report

# The Benthic Macroinvertebrates of Cottonwood Creek

Prepared for the
Trail Mountain Coal Company

by
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## Station Description

The benthic community of Cottonwood Creek was examined at two locations, Surface Water Monitoring Stations SW-1 and SW-2. These stations were sampled on July 31, 1985 and again on October 25, 1985. Station SW-1 is located upstream from the Trail Mountain Coal Company facilities. The riparian vegetation produces a closed canopy over the stream. The stream bed itself is a large rubble substrate with a matrix of sand. Station SW-2 is downstream from the mining facilities and the riparian vegetation is more open resulting in very little shading of the station. The substrate here is a small rubble with a matrix of sand. The matrix and rubble tended to be cemented together by a calcarious marl. The marl was more noticeable on the first sampling date.

## Sampling Procedure

Four samples were taken at each station. This number of samples was determined to be adequate for monitoring purposes. Samples were taken with a standard surber sampler with a 351 micron mesh net. Sampler positioning within each sampling station was determined randomly so as to eliminate any potential investigator induced bias. The substrate was removed to a depth of ten centimeters and placed in a plastic container. The contents of the surber sampler was also washed into this container. The sample was preserved with a 10% formalin solution with rose bengal stain added. The samples were washed in the laboratory and organic materials were retained in a 64 micron mesh sieve. The organic residue was washed into a bottle and preserved with the 10 % formalin - rose bengal solution until it could be sorted. The sediments were oven dried and then separated into size fractions with a Tyler sieve shaker set at 20 minutes. The size fractions were weighed to determine proportional weight content.

Sample sorting was done under a dissecting microscope. Organisms were removed and placed into two dram vials and 70% ethyl alcohol was added as a preservative. These samples were later sorted to Order and Family levels and Generic identification was accomplished with the use of several keys for aquatic invertebrates (see bibliography). Identification was made with a dissecting microscope and occasionally with the aid of a compound microscope for those specimens which required dissection and slide mounting.

## Preliminary Results

The sediment data are summarized in a table. While this only depicts the average proportional composition for each sampling site and sampling date, it does reveal the gross differences between the sediments of the two stations. SW-1 on both sampling dates had the highest proportion of the substrate particles in the 64mm + category (74% and 64% respectively). While SW-2 samples taken on 10-25-85 did have the dominant substrate as 64mm + (53%), it is also apparent that the smaller rubble sizes are more predominant. For instance the 32-8 mm size range for SW-1 was 11% and 14% for July and October respectively while the same size range for SW-2 was 40% and 25%. This implies that substrate may be important in influencing the structure of the communities at the two respective stations and a certain degree of confounding may occur when attempting to determine any impact form mining activities. An additional confounding factor was alluded to earlier, that is the difference in canopy cover at the two sites. The open canopy of station SW-2 is likely the cause of the calcareous marl on the substrate. The marl is induced by the action of photosynthetic organisms, in this case epilithic algae. This marl will reduce the interstitial spaces available to the benthic fauna and thus will

influence the community. The reduced marl on the second sampling date could be from either lower overall photosynthesis on the benthos due to season or it could result from the disturbance induced by the sampling three months earlier in July. Regardless, the samples taken in October are more comparable between stations than are those taken in July. This is easily seen in the densities of the invertebrates. The October samples are more similar between the stations than are the July samples. In July the SW-2 station has about 30% fewer taxa than SW-1, while in October SW-2 has approximately the same number of taxa. From these preliminary results it appears that the mining activities are having little or no impact on the stream communities, although more definitive conclusions must await a final analysis with quantitative methods.

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Substrate Size (%)

| Date and Sample | Rubble (mm) 64+ | 64-32 | 32-8 | Gravel (mm) 8-4 | 4-2 | 2-1 | Sand (mm) 1-.5 | .5-.25 | .25-.125 | .125-.063 |
|---|---|---|---|---|---|---|---|---|---|---|
| 7/31/85 SW-1 | 74.2 | 9.6 | 10.7 | 2.1 | 1.3 | 0.6 | 0.4 | 0.9 | 0.2 | 0.2 |
| 7/31/85 SW-2 | 12.6 | 26.3 | 39.8 | 7.8 | 4.0 | 2.5 | 2.3 | 4.4 | 0.5 | 0.1 |
| 10/25/85 SW-1 | 64.4 | 13.1 | 13.9 | 4.2 | 1.3 | 0.7 | 0.6 | 1.5 | 0.5 | 0.1 |
| 10/25/85 SW-2 | 52.8 | 14.2 | 25.0 | 4.2 | 1.2 | 0.6 | 0.4 | 1.0 | 0.5 | 0.1 |

Date: 7-31-85
Sample site: SW-1

| | Sample Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ephemeroptera | | | | |
| Baetidae | | | | |
| *Baetis* sp. | 285 | 72 | 147 | 148 |
| Heptageniidae | | | | |
| *Heptagenia* sp. | 0 | 0 | 0 | 0 |
| Plecoptera | | | | |
| Perlodidae | | | | |
| *Cultus* sp. | 29 | 19 | 8 | 13 |
| Chloroperlidae | | | | |
| *Chloroperla* sp. | 3 | 0 | 0 | 0 |
| Nemouridae | | | | |
| *Malenka* sp. | 0 | 5 | 3 | 11 |
| Trichoptera | | | | |
| Hydropsychidae | | | | |
| *Hydropsyche* sp. | 11 | 3 | 3 | 5 |
| Brachycentridae | | | | |
| *Brachycentrus* sp. | 0 | 0 | 0 | 3 |
| Limnephilidae | 0 | 0 | 0 | 0 |
| Diptera | | | | |
| Chironomidae | 24 | 3 | 21 | 5 |
| Rhagionidae | | | | |
| *Atherix variegata* | 0 | 3 | 0 | 0 |
| Simuliidae | | | | |
| *Prosimulium* sp. | 77 | 0 | 19 | 5 |
| Tipulidae | | | | |
| *Tipula* sp. | 0 | 0 | 0 | 0 |
| Coleoptera | | | | |
| Dytiscidae | | | | |
| nr. *Agabus* | 0 | 0 | 0 | 3 |
| Copepoda | | | | |
| Harpacticoida | 0 | 0 | 0 | 0 |
| Oligocheta | 19 | 64 | 8 | 11 |
| Nematoda 0 | 0 | 0 | 0 | |

Date: 7-31-85
Sample site: SW-2

| | Sample Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ephemeroptera | | | | |
| Baetidae | | | | |
| *Baetis* sp. | 259 | 149 | 155 | 75 |
| Heptageniidae | | | | |
| *Heptagenia* sp. | 0 | 0 | 0 | 0 |
| Plecoptera | | | | |
| Perlodidae | | | | |
| *Cultus* sp. | 0 | 3 | 3 | 11 |
| Chloroperlidae | | | | |
| *Chloroperla* sp. | 0 | 0 | 0 | 0 |
| Nemouridae | | | | |
| *Malenka* sp. | 0 | 3 | 8 | 3 |
| Trichoptera | | | | |
| Hydropsychidae | | | | |
| *Hydropsyche* sp. | 3 | 0 | 0 | 8 |
| Brachycentridae | | | | |
| *Brachycentrus* pp. | 0 | 0 | 0 | 0 |
| Limnephilidae | 0 | 0 | 0 | 0 |
| Diptera | | | | |
| Chironomidae | 5 | 8 | 19 | 16 |
| Rhagionidae | | | | |
| *Atherix variegata* | 0 | 0 | 0 | 0 |
| Simuliidae | | | | |
| *Prosimulium* sp. | 3 | 8 | 13 | 0 |
| Tipulidae | | | | |
| *Tipula* sp. | 0 | 0 | 0 | 0 |
| Coleoptera | | | | |
| Dytiscidae | | | | |
| nr. *Agabus* | 0 | 0 | 0 | 0 |
| Copepoda | | | | |
| Harpacticoida | 0 | 3 | 0 | 0 |
| Oligocheta | 32 | 45 | 13 | 21 |
| Nematoda 11 | 3 | 0 | 0 | |

Date: 10-25-85
Sample site: SW-1

| | Sample Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ephemeroptera | | | | |
| Baetidae | | | | |
| *Baetis* sp. | 139 | 115 | 45 | 139 |
| Heptageniidae | | | | |
| *Heptagenia* sp. | 5 | 5 | 0 | 3 |
| Plecoptera | | | | |
| Perlodidae | | | | |
| *Cultus* sp. | 5 | 11 | 0 | 8 |
| Chloroperlidae | | | | |
| *Chloroperla* sp. | 19 | 13 | 0 | 0 |
| Nemouridae | | | | |
| *Malenka* sp. | 8 | 0 | 0 | 0 |
| Trichoptera | | | | |
| Hydropsychidae | | | | |
| *Hydropsyche* sp. | 13 | 5 | 3 | 11 |
| Brachycentridae | | | | |
| *Brachycentrus* sp. | 0 | 0 | 0 | 0 |
| Limnephilidae | 0 | 0 | 0 | 0 |
| Diptera | | | | |
| Chironomidae | 5 | 12 | 11 | 24 |
| Rhagionidae | | | | |
| *Atherix variegata* | 0 | 8 | 0 | 0 |
| Simuliidae | | | | |
| *Prosimulium* sp. | 0 | 0 | 0 | 5 |
| Tipulidae | | | | |
| *Tipula* sp. | 0 | 0 | 0 | 0 |
| Coleoptera | | | | |
| Dytiscidae | | | | |
| nr. *Agabus* | 0 | 0 | 0 | 0 |
| Copepoda | | | | |
| Harpacticoida | 0 | 0 | 0 | 0 |
| Oligocheta | 19 | 29 | 53 | 35 |
| Nematoda 0 | 0 | 3 | 0 | |

Date: 10-25-85
Sample site: SW-2

| | Sample Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Ephemeroptera | | | | |
| Baetidae | | | | |
| *Baetis* sp. | 557 | 275 | 93 | 115 |
| Heptageniidae | | | | |
| *Heptagenia* sp. | 0 | 8 | 3 | 0 |
| Plecoptera | | | | |
| Perlodidae | | | | |
| *Cultus* sp. | 27 | 16 | 5 | 0 |
| Chloroperlidae | | | | |
| *Chloroperla* sp. | 12 | 0 | 3 | 0 |
| Nemouridae | | | | |
| *Malenka* sp. | 0 | 0 | 0 | 0 |
| Trichoptera | | | | |
| Hydropsychidae | | | | |
| *Hydropsyche* sp. | 3 | 3 | 5 | 0 |
| Brachycentridae | | | | |
| *Brachycentrus* sp. | 0 | 0 | 0 | 0 |
| Limnephilidae | 3 | 0 | 0 | 3 |
| Diptera | | | | |
| Chironomidae | 5 | 275 | 83 | 261 |
| Rhagionidae | | | | |
| *Atherix variegata* | 3 | 0 | 3 | 0 |
| Simuliidae | | | | |
| *Prosimulium* sp. | 0 | 0 | 0 | 0 |
| Tipulidae | | | | |
| *Tipula* sp. | 5 | 0 | 0 | 0 |
| Coleoptera | | | | |
| Dytiscidae | | | | |
| nr. *Agabus* | 0 | 0 | 3 | 0 |
| Copepoda | | | | |
| Harpacticoida | 0 | 0 | 0 | 0 |
| Oligocheta | 77 | 45 | 3 | 64 |
| Nematoda 8 | 0 | 0 | 0 | |

# Final Report

# Cottonwood Creek Macroinvertebrate Assessment

# for the

# Trail Mountain Coal Company

by

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## Introduction and Purpose

The Utah Division of Oil, Gas and Mining and the United States Department of the Interior have required a study of the Cottonwood Creek macroinvertebrate community with the objective of documenting any negative impacts of the Trail Mountain Coal Company mining operations on the stream system. The instructions were to compare the faunal elements over three sampling periods at two stations on Cottonwood Creek. A total of four samples per station were recommended. This report details the results of the study and interprets the similarities and dissimilarities of the two communities and the habitat found at each station.

## Description of Study Area

The study was conducted from two preestablished sampling stations in Cottonwood Canyon, Emery County, Utah. These sites are the surface water monitoring stations SW-1 and SW-2 of the Hydrologic Monitoring program established by the Trail Mountain Coal Company in compliance with requirements by the Utah Division of Oil, Gas & Mining and the United States Department of the Interior. SW-1 is above the Trail Mountain Coal Company mining facilities and represents a control, or non impact section. SW-2 is approximately one kilometer downstream from the facilities and represents the portion of the stream where mining impacts would be expected if such impacts occur.

The upstream station, SW-1 is located in a shaded portion of the stream, with a relatively dense overhead canopy of Cottonwood (Populus sp.) and a riparian of varied native shrubs. The stream passes through a narrow channel, confined by steep side walls. The substrate is large rubble with a sand matrix. SW-2 is in a more open setting, and has significantly less overstory cover. The stream bed is, for the most part, exposed to direct sunlight. The bank slopes gradually to the stream bed from the east, while the western bank is steep, similar to the banks at location SW-1. The substrate here is a small rubble with a matrix of sand. The matrix and rubble tended to be cemented together with a calcarious marl, and this marl was best developed during the summer sampling period.

## Materials and Methods

### Sampling Methods

Samples were taken three times during the year: July 31, 1985; October 25, 1985 and February 9, 1986. Four replicate samples were taken per station using a one square foot surber sampler with a net mesh of 351 microns. The positioning of each sample was determined with random numbers to avoid any bias by the investigator. Once the sample position was determined, the surber sampler was centered directly over the sampling point. Large rocks found within the sample area were washed and measured in the field, but were not retained for laboratory processing. The volume of each rock was used to determine its approximate weight for sediment analysis. The remaining substrate in each sample was removed to a depth of 4 inches (10 cm.) and placed in a polyethylene jar. Excess water was removed by filtering through a 64 micron mesh sieve. The contents of the surber sampler net was also washed into the sieve and then transferred into the jar. Samples

were preserved with ten percent formalin. Rose bengal stain was added to aid in laboratory processing.

Samples were transported to the laboratory where the sediments were separated from the benthic invertebrates using elutriation (Shiozawa 1986). The elutriated organic residue was collected with a 65 micron mesh sieve, washed into a jar, and preserved with a 10% formalin - rose bengal solution. The inorganic residual was retained for sediment analysis. The samples were picked under a stereo dissecting scope and the recovered invertebrates were sorted and separated by genus or species when possible. The sediments were oven dried at 120 degrees centigrade to a constant weight. The dried material was then placed in a series of nested sieves sized according to the phi scale (Cummins, 1962; Cummins and Lauff, 1969), beginning at 250 microns mesh diameter. The sieves were then placed on a Tyler sediment shaker for 20 minutes. The size fractions were weighed and the resulting percents were used to characterize the sediments distribution in each sample.

Samples were sorted with a dissecting microscope using fiber optics lighting. Organisms were enumerated and placed into vials. The sorted invertebrates were preserved with 70% ethyl alcohol. The preserved samples were later sorted to Order and Family and the Genus and Species were determined when possible using standard keys for aquatic invertebrates (Baumann, Gaufin and Surdick, 1977; Edmondson, 1959; Edmunds, Jensen and Berner, 1976; Hitchcock, 1974; Merritt and Cummins,1978; Ross, 1944; Usinger, 1971; Wiggens, 1977). Identifications were made under a dissecting microscope and occasionally with slide mounted specimens viewed with a compound microscope.

## Results and Discussion

Analysis of aquatic impact data has traditionally focused on either the invertebrate community or the water chemistry of the stream areas in question. Water chemistry (which has been monitored separately and is not of consideration in this report) has the advantage of giving direct levels of potential contaminants reaching a given site and, in that sense, simplifies management decisions when pre-established toxicant levels are exceeded. However water chemistry varies regionally as well as seasonally (Hem 1970), and the conditions present in one system can remove or neutralize materials which might be toxic or stressful under other conditions. In addition a serial water sampling program represents point data and does not detect pollutants which may enter the system for only short periods of time, such as immediately following a storm (storm runoff) or materials that are only periodically discharged into the stream system. Materials which may enter the stream in sublethal quantities can still impact the aquatic community yet not exceed established standards and some materials may be difficult or prohibitively expensive to measure and assess chemically. The use of the biotic community is advantageous under such conditions. Lotic organisms will respond to stress if it exceeds their tolerance limits. Thus a single slug flow of a toxicant may result in the elimination or reduction of certain species and favor the multiplication or survival of other more tolerant species. The resulting shift in community structure can be detected long after the stressing factor(s) have left the system. This initially led investigators to develop the concept of indicator species

(Gaufin and Tarzwell, 1956; Tarzwell and Gaufin, 1953) where certain species were considered to be indicative of stress, especially organic pollution. If these indicators were present, then pollution was likely.

Later with the adaptation of information theory to ecology (Margalef 1957) an additional tool was made available for such evaluation. Information theory predicted that the number of pathways available for information transfer was directly correlated with the stability of information systems. A direct adaptation of this concept to that of trophic associations and food web connectivity led to the widespread use of diversity indices as a measure of the stability of natural and perturbed systems ( Margalef, 1957; MacArthur, 1972; Patrick, 1963; Pielou, 1975). The Shannon-Weiner (Shannon and Weaver 1949) index of diversity became widely used in evaluating impacts in the early 1970's. This index for diversity is:

$$H' = \text{sum}(p_i * \log(p_i))$$

where H' = the Shannon Weiner Index of diversity
$p_i$ = the proportion of species i in the sampled community

This function is maximum when $p_i = 1/S$ for all S species in the sample. That is:

$$H'max = S((1/S)*\log(1/S))$$

where H'max = the maximum diversity
S = the total number of species in the sample

Assuming that the ideal community would have maximum diversity, the nearness to this ideal state could be calculated. This measure of nearness to the ideal is called evenness and is found with the formula:

$$E = H'/H'max$$

where E = evenness
H' = the Shannon-Weiner Diversity Index
H' = the maximum diversity index defined above

Evenness ranges between 0 and 1 where 1 is maximum evenness.

As more was understood about natural communities the connection between diversity and stability began to come under question (see Pielou, 1975) and the use of diversity and evenness alone as an index of environmental stress became limited. An association between diversity and stability may exist (May, 1974) but that association is in no way as simplistic as the original users of information theory had assumed. The most reasonable use of diversity indices now are for comparisons of adjacent sites, such as is the case in this study where two stations on the same stream are being compared. Regional and broad geographical comparisons are likely to be less valid, especially when interpretations associated with the condition or quality of various systems are being considered.

In 1972 Chutter recommended the use of a biotic index to assess the impact of perturbations on aquatic systems. This index was designed to allow a

quantitative evaluation of the indicator species concept. All species in the sampled station are enumerated and each is assigned a value according to it's importance as an indicator. The higher the value, the higher the tolerance is to stressful conditions. Species values range from zero to ten and the density of each species is included in the computation of the index. The index is:

$$BI = (Sum(n_i * s_i))/N$$

where BI = the biotic index
$n_i$ = the importance value of the ith species
$s_i$ = the density of species i in the sample being evaluated
N = the total number of organisms in the sample

Here values of unperturbed systems are generally considered to be in the range of 0-2, while values of 2-4 indicate slightly enriched (stressed) situations, 4-7 are typical of enriched waters and 7-10 are characteristic of polluted waters (Hilsenhoff 1977).

Additional factors can be useful when interpreting the relative conditions of several sites. One is the influence of substrate on community structure (DeMarch, 1976) and another is the functional grouping of stream organisms (Cummins 1974). In this report these various techniques were used in extracting information relative to the impact of the Trail Mountain Coal company operations on Cottonwood Creek.

Sediment Characterization

The sediment size frequencies for each sample taken during the study are listed in Tables I, II and III. Sediments have been shown to undergo a seasonal change in structure associated with annual changes in discharge in some stream systems (DeMarch, 1976; Shiozawa, 1986). This has implications for community structure since the substrate essentially establishes the template on which the community is structured (Shiozawa 1983). Differences in sediment dynamics or in sediment structure at the two stations could induce differences in the community structure and thus complicate the interpretation of the data. Station SW-1 shifts from slightly higher percentages in the 64+mm size range to more in the 32-8 mm sizes between July and October of 1985. These particles are in the gravel sizes, and indicate selective erosion of sands from the substrate. Essentially no change in substrate size frequency occurred between October and the February samples at SW-1. Station SW-2 underwent an increase in the coarse material greater than 64 mm in size between July and October. This implies the erosion of sands and gravels from the substrate. Between October and February the proportion of gravels increased in the samples and deposition is the likely source of materials. It appears that the stations are undergoing different sediment dynamics. If annual sediment deposition - erosion cycles occur, then station SW-1 is undergoing a change from a depositional environment in the early-mid summer to an erosional one in the fall. Over the winter it stabilizes and in the spring runoff it should become erosional again. Once water levels stabilize the stream becomes depositional, replacing the materials lost to the spring floods. Station SW-2 underwent an erosional period between July and October with

Table I. Sediment size frequency data for samples collected on 7-31-85

Station: SW-1 — Percent Composition

| Sample | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
|---|---|---|---|---|---|---|---|---|
| 1 | 82.1 | 8.3 | 7.6 | 0.8 | 0.4 | 0.2 | 0.2 | 0.4 |
| 2 | 62.8 | 16.9 | 12.9 | 3.1 | 1.7 | 0.8 | 0.5 | 1.3 |
| 3 | 75.8 | 13.0 | 7.7 | 1.2 | 0.7 | 0.3 | 0.2 | 1.1 |
| 4 | 75.9 | 0.0 | 14.4 | 3.5 | 2.2 | 1.1 | 0.8 | 2.1 |
| Mean | 74.15 | 9.55 | 10.65 | 2.15 | 1.25 | 0.60 | 0.43 | 1.23 |
| Std. Deviation | 7.03 | 6.30 | 3.05 | 1.17 | 0.73 | 0.37 | 0.25 | 0.61 |

Mean Sediment Diversity: 0.929741
Mean Sediment Evenness: 0.447111

Station: SW-2 — Percent Composition

| Sample | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
|---|---|---|---|---|---|---|---|---|
| 1 | 34.2 | 33.7 | 19.7 | 7.8 | 1.7 | 0.9 | 0.6 | 1.4 |
| 2 | 16.0 | 28.0 | 17.9 | 9.6 | 6.3 | 4.9 | 5.7 | 11.6 |
| 3 | 0.0 | 0.0 | 75.9 | 8.8 | 5.7 | 3.1 | 2.1 | 4.4 |
| 4 | 0.0 | 43.3 | 45.6 | 4.9 | 2.3 | 1.0 | 0.6 | 2.3 |
| Mean | 12.55 | 26.25 | 39.78 | 7.78 | 4.00 | 2.48 | 2.25 | 4.93 |
| Std. Deviation | 14.10 | 26.25 | 23.56 | 1.79 | 2.02 | 1.65 | 2.05 | 4.00 |

Mean Sediment Diversity: 1.630813
Mean Sediment Evenness: 0.784255

Table II. Sediment size frequency data for samples collected on 10-25-85

Station: SW-1

| Sample | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
|---|---|---|---|---|---|---|---|---|
| | Percent Composition | | | | | | | |
| 1 | 55.3 | 16.9 | 21.9 | 3.0 | 0.8 | 0.4 | 0.3 | 1.4 |
| 2 | 79.9 | 14.7 | 2.6 | 1.1 | 0.6 | 0.3 | 0.2 | 0.6 |
| 3 | 76.9 | 7.1 | 9.7 | 2.3 | 1.3 | 0.7 | 0.5 | 1.5 |
| 4 | 45.3 | 13.8 | 21.5 | 10.5 | 2.4 | 1.3 | 1.2 | 4.0 |
| Mean | 64.35 | 13.13 | 13.93 | 4.23 | 1.28 | 0.68 | 0.55 | 1.88 |
| Std. Deviation | 14.53 | 3.66 | 8.17 | 3.69 | 0.70 | 0.39 | 0.39 | 1.28 |

Mean Sediment Diversity: 1.150947
Mean Sediment Evenness: 0.553958

Station: SW-2

| Sample | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
|---|---|---|---|---|---|---|---|---|
| | Percent Composition | | | | | | | |
| 1 | 0.0 | 35.9 | 43.6 | 13.1 | 3.1 | 1.5 | 0.9 | 1.9 |
| 2 | 71.2 | 14.4 | 10.9 | 1.5 | 0.6 | 0.3 | 0.2 | 0.9 |
| 3 | 55.9 | 7.5 | 32.8 | 1.3 | 0.9 | 0.4 | 0.3 | 0.9 |
| 4 | 84.6 | 0.0 | 12.7 | 0.9 | 0.3 | 0.3 | 0.3 | 0.9 |
| Mean | 52.93 | 14.45 | 25.00 | 4.20 | 1.23 | 0.63 | 0.43 | 1.15 |
| Std. Deviation | 32.20 | 13.39 | 13.76 | 5.14 | 1.10 | 0.51 | 0.28 | 0.43 |

Mean Sediment Diversity: 1.256215
Mean Sediment Evenness: 0.604112

Table III. Sediment size frequency data for samples collected on 2-9-86

Station: SW-1

| Sample | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
|---|---|---|---|---|---|---|---|---|
| | Percent Composition | | | | | | | |
| 1 | 46.2 | 12.5 | 21.8 | 7.6 | 3.9 | 2.2 | 1.9 | 3.9 |
| 2 | 85.0 | 3.6 | 6.1 | 1.9 | 1.0 | 0.7 | 0.7 | 1.0 |
| 3 | 72.8 | 11.8 | 10.2 | 2.5 | 0.9 | 0.4 | 0.3 | 1.1 |
| 4 | 58.0 | 22.0 | 16.6 | 1.9 | 0.7 | 0.3 | 0.2 | 0.3 |
| Mean | 65.50 | 12.48 | 13.68 | 3.48 | 1.63 | 0.90 | 0.78 | 1.58 |
| Std. Deviation | 14.68 | 6.52 | 6.00 | 2.39 | 1.32 | 0.76 | 0.68 | 0.38 |

Mean Sediment Diversity: 1.138008
Mean Sediment Evenness: 0.547266

Station: SW-2

| Sample | 64+ | 32-64 | 8-32 | 4-8 | 2-4 | 1-2 | .5-1 | .25-.5 |
|---|---|---|---|---|---|---|---|---|
| | Percent Composition | | | | | | | |
| 1 | 0.0 | 39.3 | 42.0 | 5.8 | 2.8 | 2.0 | 2.2 | 5.9 |
| 2 | 79.2 | 5.3 | 8.9 | 3.3 | 1.8 | 0.9 | 0.4 | 0.2 |
| 3 | 0.0 | 9.8 | 77.1 | 7.7 | 2.8 | 1.2 | 0.6 | 0.8 |
| 4 | 13.5 | 14.7 | 58.0 | 6.5 | 2.8 | 1.3 | 0.9 | 1.9 |
| Mean | 23.18 | 17.28 | 46.60 | 5.83 | 2.55 | 1.35 | 1.03 | 2.20 |
| Std. Deviation | 32.81 | 13.14 | 25.06 | 1.61 | 0.43 | 0.40 | 0.70 | 2.22 |

Mean Sediment Diversity: 1.446200
Mean Sediment Evenness: 0.695475

even more coarse materials being removed than in station SW-1. From October to February deposition occurred. In the spring the runoff would again be expected to act as an erosional factor. The difference in the size of particles deposited is indicative of the stream velocity in the two sites. Station SW-2 has a higher gradient than does station SW-1 and higher velocity water will carry larger particles. However the sediment determinations were based upon the four replicate random samples. Other studies (DeMarch, 1976; Shiozawa, 1986) relied upon more replicates per station and sampled much more frequently when deriving the seasonal patterns. Thus the three sampling periods used here can give only partial support of such seasonal trends existing in Cottonwood Creek. It is obvious that the substrates at the two sites are quite different, especially during the July and February sampling periods.

Some of the differences between the sediments at SW-1 and SW-2 are associated with the high carbonate content at location SW-2. The open exposure of the eastern bank of the stream at SW-2 and the lack of an overhead canopy combine to favor photosynthesis of algae. Under condition of very active photosynthesis, algae can switch from utilizing dissolved $CO_2$ in the water to utilizing carbon dioxide in the bicarbonate form. Extraction of $CO_2$ from the bicarbonate, $HCO_3^-$, leaves a hydroxide group ($OH^-$) which then reacts with other bicarbonates to form insoluble carbonate complexes. These complexes cement the substrate together in the form of a calcareous marl. The benthos of SW-2 was cemented in place by such a marl when samples were taken in July. Less cementing was noted when sampling in November and February. The lower marl presence in the fall and winter may be due to lower primary production associated with shorter days in the narrow canyon in which the sampling stations are located, or it may be an artifact resulting from the initial disturbance of the stream channel by the July sampling. The answer to this cannot be determined without further sampling. Station SW-1 did not have marl deposits during any of the sampling periods. This was to be expected because of the overhead canopy which would reduce the rate of algal photosynthesis.

The differences in the sediments collected from the two stations are summarized in Table IV. A comparison of sediment weight based on both modal and median weight frequencies also indicates the differences between stations SW-1 and SW-2. SW-2 samples in general had a smaller modal and median size although this difference is not apparent in the October samples. Diversity and evenness of each sample is also listed in Table IV. The diversity value gives a relative picture of the distribution of the sediment weights. The lower the diversity, the more a single size class dominates the sample. Again both diversity and evenness indicate that the sediments in station SW-1 are more skewed in distribution than are those in station SW-2 with the exception of the October sampling series.

Benthic Invertebrate Community

The benthic invertebrate community consisted of 15 taxa representing eight orders. The distributions of the invertebrates resulted in a high variance to mean ratio which implies a contagious distribution. Such patterns are typical of stream systems and the currently accepted treatment of such data is to utilize the geometric confidence limits based on a $\log(x+1)$ transformation on the arithmetic mean (Elliott, 1977; Shiozawa and Barnes,

1977). For that reason the confidence limits about each species will not be symmetrical. It is important to recognize that contagious distributions predominate in most benthic groups, and that this distributional pattern further limits the accuracy of small numbers of replicate samples.

The predominant benthic invertebrate groups collected included the mayflies, especially Baetis, perlodid and nemourid stoneflies, hydropsychid caddisflies, chironomids, simuliids and oligochaetes. These taxa can be placed into functional group designations (Cummins, 1974; Merritt and Cummins, 1978) which can add insight into the functional structures of the two sites. The stations can be compared over time as well as between each other for differences in functional groupings. The functional group concept of Cummins (1974) is based on the processing of food in the stream system. Most streams have a considerable portion of their energetic budget supplied by the surrounding riparian vegetation. The resulting food web is thus detrital based, and the functional groups correspond to the role which various species play in processing food within the system. Whole leaves, after being conditioned by bacteria and fungi are broken into smaller particles by shredders. The finer particles are collected from the flowing water by filterers, and those particles which settle out onto the stream bed are fed upon by the collector-gatherers. Grazers are those species which actively feed on living plant materials, algae being the main food source, while those designated as grazer/scrapers may also feed on epilithic detritus. Predators are those species which feed upon other benthic invertebrates.

In July SW-1 (Table V) had abundant collector-gatherers (Baetis, Chironomids, oligochaetes) and filter feeders (Brachycentrus, Hydropsyche and Prosimulium. Predators were represented by the plecopterans Cultus and Choloroperla, rhagionid fly larvae and the dytiscid beetle larvae, Agabus. The only shredder at SW-1 was Melanka (Plecoptera). The October (Table VI) samples had a decrease in shredder (still the one plecopteran species) and predator densities. The grazer/scraper Heptagenia (Ephemeroptera) occurred, possibly as a partial response to the open canopy following leaf drop and to the increased organic flocculates on the rock surfaces. The collector gatherers were in slightly lower densities. By February (Table VII) the collector gatherer Baetis was in low density but the chironomids, also collector gatherers, had increased to over ten times their October densities. The grazer Heptagenia was still present and the shredders were predominantly represented by Tipula and limnephilid caddisflies. The filterers were still present but the hydropsychid caddisflies decreased in density and the simuliid larvae became more abundant.

The July (Table VIII) samples from Station SW-2 had collector gatherer densities virtually identical to that of SW-1. The filter feeders were lower in density than those at station SW-1, but this difference was strongly influenced by the substrate size distribution. Filter feeders require a substratum for attachment and from the sediment analysis for SW-2 (Table I) it is apparent that the dominant substrate in July was gravel, too unstable for the development of a high filter feeder density. Shredders were also in lower densities in the SW-2 July samples, but with the high variance associated with the contagious distributions of this group the difference is not significant. The only predator in station SW-2 for July was the plecopteran Cultus. Its densities were approximately one fourth

Table IV. Sediment Data Summary

| Date: 7-31-85 | modal size | median size | Diversity | Evenness |
|---|---|---|---|---|
| SW-1 1 | 64+ | 64+ | 0.67201 | 0.323172 |
| SW-1 2 | 64+ | 64+ | 1.15532 | 0.555594 |
| SW-1 3 | 64+ | 64+ | 0.83994 | 0.403928 |
| SW-1 4 | 64+ | 64+ | 0.85902 | 0.413103 |
| mean conditions: | 64+ | 64+ | 0.92974* | 0.447111* |
| | | | | |
| SW-2 1 | 32-64 | 64+ | 1.45463 | 0.699529 |
| SW-2 2 | 8-32 | 32-64 | 1.91767 | 0.922209 |
| SW-2 3 | 8-32 | 8-32 | 0.91271 | 0.438922 |
| SW-2 4 | 8-32 | 8-32 | 1.11856 | 0.537914 |
| mean conditions | 8-32 | 8-32 | 1.63081* | 0.784255* |
| | | | | |
| Date: 10-25-85 | | | | |
| SW-1 1 | 64+ | 64+ | 1.20374 | 0.578878 |
| SW-1 2 | 64+ | 64+ | 0.69688 | 0.335131 |
| SW-1 3 | 64+ | 64+ | 0.88353 | 0.424889 |
| SW-1 4 | 32-64 | 64+ | 1.52695 | 0.734307 |
| mean conditions | 64+ | 64+ | 1.15095* | 0.553958* |
| | | | | |
| SW-2 1 | 8-32 | 8-32 | 1.28434 | 0.617639 |
| SW-2 2 | 64+ | 64+ | 0.92844 | 0.446487 |
| SW-2 3 | 64+ | 64+ | 1.06578 | 0.512532 |
| SW-2 4 | 64+ | 64+ | 0.54062 | 0.259986 |
| mean conditions | 64+ | 64+ | 1.25622* | 0.604112* |
| | | | | |
| Date 2-9-86 | | | | |
| SW-1 1 | 32-64 | 32-64 | 1.55692 | 0.748722 |
| SW-1 2 | 64+ | 64+ | 0.66529 | 0.319939 |
| SW-1 3 | 64+ | 64+ | 0.93986 | 0.451978 |
| SW-1 4 | 64+ | 64+ | 1.10446 | 0.531136 |
| mean conditions | 64+ | 64+ | 1.13801* | 0.547266* |
| | | | | |
| SW-2 1 | 8-32 | 8-32 | 1.32584 | 0.637594 |
| SW-2 2 | 64+ | 64+ | 0.81747 | 0.393120 |
| SW-2 3 | 8-32 | 8-32 | 0.84808 | 0.407840 |
| SW-2 4 | 8-32 | 8-32 | 1.33412 | 0.641577 |
| mean conditions | 8-32 | 8-32 | 1.446208* | 0.695475* |

* note that these values are based on the mean percent composition values from Tables I,II,III and are not arithmetic means of the individual diversity and evenness values.

Table V. Invertebrate density, diversity, evenness and biotic index for site SW-1, July 31, 1985.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 1754.52 | 716.11 | 4276.38 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 0.0 | - | - |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 185.68 | 76.12 | 433.37 |
| Chloroperlidae | | | |
| *Chloroperla sp.* | 8.07 | -4.51 | 45.98 |
| Nemouridae | | | |
| *Melanka sp.* | 51.13 | 0.93 | 316.72 |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 59.20 | 19.91 | 148.82 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 8.07 | -4.51 | 45.98 |
| Limnephillidae | 0.0 | - | - |
| Diptera | | | |
| Chironomidae | 142.62 | 24.69 | 652.80 |
| Rhagionidae | | | |
| *Athrix varigata* | 8.07 | -4.51 | 45.98 |
| Simuliidae | | | |
| *Prosimulium sp.* | 271.79 | 4.14 | 5347.37 |
| Tipulidae | | | |
| *Tipula sp.* | 0.0 | - | - |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 8.07 | -4.51 | 45.98 |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 274.48 | 60.42 | 1132.24 |
| Nematoda | 0.0 | - | - |
| Total Invertebrates | 2771.70 | | |

| | |
|---|---|
| Number of Taxa | 11 |
| H' Max | 2.397895 |
| Diversity, H' | 1.303748 |
| Evenness | 0.543705 |
| Biotic Index (Hilsenhoff 1977) | 2.0748 |

Table VI. Invertebrate density, diversity, evenness and biotic index for site SW-1, October 25, 1985.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 1178.65 | 498.96 | 2764.67 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 34.98 | 4.11 | 65.86 |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 64.58 | 2.00 | 433.92 |
| Chloperlidae | | | |
| *Chloroperla sp.* | 86.11 | -3.56 | 1291.33 |
| Nemouridae | | | |
| *Melanka sp.* | 21.53 | -5.14 | 174.67 |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 86.11 | 27.19 | 236.51 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 0.0 | - | - |
| Limnephillidae | 0.0 | - | - |
| Diptera | | | |
| Chironomidae | 139.93 | 48.78 | 370.63 |
| Rhagionidae | | | |
| *Athrix varigata* | 21.53 | -5.14 | 174.67 |
| Simuliidae | | | |
| *Prosimulium sp.* | 13.45 | -4.94 | 89.97 |
| Tipulidae | | | |
| *Tipula sp.* | 0.0 | - | - |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 0.0 | - | - |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 365.97 | 184.75 | 715.17 |
| Nematoda | 8.07 | -4.51 | 45.98 |
| Total Invertebrates | 2020.92 | | |

| | |
|---|---|
| Number of Taxa | 11 |
| H' Max | 2.397895 |
| Diversity, H' | 1.410172 |
| Evenness | 0.588087 |
| Biotic Index (Hilsenhoff 1977) | 2.0719 |

Table VII. Invertebrate density, diversity, evenness and biotic index for site SW-1, February 9, 1986.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 861.11 | 161.00 | 4414.80 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 45.75 | 10.44 | 81.05 |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 26.91 | -0.17 | 53.99 |
| Chloroperlidae | | | |
| *Chloroperla sp.* | 24.22 | -1.47 | 49.91 |
| Nemouridae | | | |
| *Melanka sp.* | 8.07 | -4.51 | 45.98 |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 69.97 | 17.75 | 217.80 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 0.0 | - | - |
| Limnephillidae | 16.15 | -4.83 | 37.12 |
| Diptera | | | |
| Chironomidae | 4039.15 | 1675.14 | 9718.06 |
| Rhagionidae | | | |
| *Athrix varigata* | 0.0 | - | - |
| Simuliidae | | | |
| *Prosimulium sp.* | 91.49 | 2.94 | 752.20 |
| Tipulidae | | | |
| *Tipula sp.* | 29.60 | 1.20 | 58.00 |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 8.07 | -4.5 | 45.98 |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 129.17 | -3.24 | 2591.57 |
| Nematoda | 0.0 | - | - |
| Total Invertebrates | 5349.66 | | |

| | |
|---|---|
| Number of Taxa | 12 |
| H' Max | 2.484906 |
| Diversity, H' | 0.880037 |
| Evenness | 0.354153 |
| Biotic Index (Hilsenhoff 1977) | 2.0645 |

Table VIII. Invertebrate density, diversity, evenness and biotic index for site SW-2, July 31, 1985.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 1716.84 | 763.14 | 3845.84 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 0.0 | - | - |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 45.75 | 0.43 | 274.62 |
| Chloperlidae | | | |
| *Chloroperla sp.* | 0.0 | - | - |
| Nemouridae | | | |
| *Melanka sp.* | 37.67 | 0.58 | 196.02 |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 29.60 | -3.59 | 216.48 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 0.0 | - | - |
| Limnephillidae | 0.0 | - | - |
| Diptera | | | |
| Chironomidae | 129.17 | 46.62 | 330.47 |
| Rhagionidae | | | |
| *Athrix variqata* | 0.0 | - | - |
| Simuliidae | | | |
| *Prosimulium sp.* | 64.58 | 1.14 | 466.02 |
| Tipulidae | | | |
| *Tipula sp.* | 0.0 | - | - |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 0.0 | - | - |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 8.07 | -4.51 | 45.98 |
| Annellida | | | |
| Oligochaeta | 298.70 | 125.78 | 690.58 |
| Nematoda | 37.67 | -3.63 | 318.25 |
| Total Invertebrates | 2368.06 | | |

| | |
|---|---|
| Number of Taxa | 9 |
| H' Max | 2.197224 |
| Diversity, H' | 1.033331 |
| Evenness | 0.470289 |
| Biotic Index (Hilsenhoff 1977) | 2.3216 |

of that of the same species at SW-1.

In October (Table IX) the invertebrate density in SW-2 was double that of SW-1. Baetis was 2.5 times more abundant and the midge larvae (Chironomidae) were approximately ten times more abundant. Both the predacious stoneflies and the grazer Heptagenia were present in approximately the same density as in SW-1. The grazer was not present in SW-2 in July, and the change to more favorable substrate size classes are associated with its October occurrence. Filter feeders were less abundant. The simuliids appear to have undergone a fall emergence prior to the October sampling date and therefore were absent. The hydropsychid caddisflies were significantly lower in density than those in SW-1 for October, and were about the same density as they were in the previous SW-2 samples taken in July. The cause of this difference is not clear and the data taken in this project will not allow a resolution of this problem. One factor which could be influential is the lower drift rates of later instar hydropsychid caddisflies which slows dispersal and would therefore imply that later instar hydropsychids would be slow in colonizing newly opened habitat. However the ability of such behavioral factors to control densities several months later seems unlikely.

The February samples from SW-2 (Table X) are indicative of the stressful conditions which exist in the stream during the winter. At the time of sampling frazzle ice was present and it appeared that anchor ice had occurred as well. Invertebrate densities were approximately one eighth the October level. The location of SW-2 with its open exposure would increase the likelihood of anchor ice formation. In addition the sediments collected in February had shifted back to gravel (Table IV) which would also favor reduced numbers of species. The total invertebrate density in SW-2 was also about one eighth of that of SW-1 on that same sampling date. The functional groups present include mostly collector gatherers. A few filterers (hydropsychids) and shredders (Tipula) were collected, but in general the community appeared as a vagrant benthos with opportunistic species being dominant.

Diversity, evenness and the biotic index were also computed for the benthic communities. Highest diversity for SW-1 and SW-2 occurred during October. The lowest diversity for both stations occurred in February. SW-2 had the lowest diversity value in July and October samples but in February SW-1 was found to have the lowest diversity. At this time SW-2 had 6 taxa and SW-1 had 12 taxa but the evenness of SW-1 was much lower than that of SW-2. Wilhm (1970) proposed diversity indices less than one to be indicative of stressed or polluted systems while values above 3 represented clean water conditions. On this basis both stations are borderline polluted or polluted. Neither would fall into the clean water categories.

The biotic index, based on the computed values of Hilsenhoff (1972) was also used to compare the benthic communities. SW-2 had consistently higher biotic index values throughout the three sampling periods, averaging 2.3493 while SW-1 averaged 2.0704. Values between 0-2 are indicative of clean water conditions and values between 2 and 3 are indicative of sightly stressed conditions (Hilsenhoff 1972). Thus SW-1 is at worst very slightly stressed on the biotic index rating and SW-2 is only slightly but significantly more so. However much of the stress is can be attributed to the differences

Table IX. Invertebrate density, diversity, evenness and biotic index for site SW-2, October 25, 1985.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 2798.61 | 750.00 | 10363.83 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 29.60 | -3.59 | 216.48 |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 129.17 | 2.66 | 1447.76 |
| Chloperlidae | | | |
| *Chloroperla sp.* | 40.36 | -3.63 | 355.72 |
| Nemouridae | | | |
| *Melanka sp.* | 0.0 | - | - |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 26.91 | 0.35 | 116.96 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 0.0 | - | - |
| Limnephillidae | 16.16 | -4.83 | 37.12 |
| Diptera | | | |
| Chironomidae | 1679.17 | 86.66 | 29303.24 |
| Rhagionidae | | | |
| *Athrix varigata* | 16.15 | -4.83 | 37.12 |
| Simuliidae | | | |
| *Prosimulium sp.* | 0.0 | - | - |
| Tipulidae | | | |
| *Tipula sp.* | 13.45 | -4.94 | 89.97 |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 8.07 | -4.51 | 45.98 |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 508.59 | 46.65 | 4687.38 |
| Nematoda | 21.53 | -5.14 | 174.67 |
| Total Invertebrates | 5287.77 | | |

| | |
|---|---|
| Number of Taxa | 12 |
| H' Max | 2.484906 |
| Diversity, H' | 1.192904 |
| Evenness | 0.480060 |
| Biotic Index (Hilsenhoff 1977) | 2.2651 |

Table X. Invertebrate density, diversity, evenness and biotic index for site SW-2, February 9, 1986.

| | no./sq. meter | 95% confidence interval lower | upper |
|---|---|---|---|
| Ephemeroptera | | | |
| Baetidae | | | |
| *Baetis sp.* | 441.32 | 91.01 | 1997.33 |
| Heptageniidae | | | |
| *Heptagenia sp.* | 0.0 | - | - |
| Plecoptera | | | |
| Perlodidae | | | |
| *Cultus sp.* | 0.0 | - | - |
| Chloroperlidae | | | |
| *Chloroperla sp.* | 8.07 | -6.76 | 22.90 |
| Nemouridae | | | |
| *Melanka sp.* | 0.0 | - | - |
| Trichoptera | | | |
| Hydropsychidae | | | |
| *Hydropsyche sp.* | 8.07 | -4.51 | 45.98 |
| Brachycentridae | | | |
| *Brachycentrus sp.* | 0.0 | - | - |
| Limnephillidae | 0.0 | - | - |
| Diptera | | | |
| Chironomidae | 123.78 | -0.97 | 1837.34 |
| Rhagionidae | | | |
| *Athrix varigata* | 0.0 | - | - |
| Simuliidae | | | |
| *Prosimulium sp.* | 0.0 | - | - |
| Tipulidae | | | |
| *Tipula sp.* | 13.45 | -4.94 | 89.97 |
| Coleoptera | | | |
| Dytiscidae | | | |
| *Agabus sp.* | 0.0 | - | - |
| Crustacea | | | |
| Copepoda | | | |
| Harpacticoida | 0.0 | - | - |
| Annellida | | | |
| Oligochaeta | 64.58 | -3.56 | 776.95 |
| Nematoda | 0.0 | - | - |
| Total Invertebrates | 659.29 | | |

| | |
|---|---|
| Number of Taxa | 6 |
| H' Max | 1.791759 |
| Diversity, H' | 0.997553 |
| Evenness | 0.556744 |
| Biotic Index (Hilsenhoff 1977) | 2.4612 |

of substrate size, a factor not fully considered in the derivation of the biotic index.

The final technique used to evaluate the samples was a form of multivariate analysis known as cluster analysis. Cluster analysis utilizes a similarity matrix based on comparisons of all possible pairs of samples in the study. The similarity can be measured with any index, including those based on presence and absence as well as on quantitative comparisons. In this study correlation coefficients were used as the measure of similarity. The resulting correlation matrices are listed in Tables XI and XII. Table XI lists the correlations of all possible pairs of sediment samples and Table XII lists the correlations for all pairs of benthic invertebrate samples. Cluster dendrograms for the sediments (Figure 1) and the benthic invertebrate communities (Figure 2) were prepared from the correlation matrices. The algorithm used was the unweighted pair-group arithmetic averaging method (Sokal and Sneath, 1963; Sneath and Sokal, 1973). The initial purpose of clustering was to check for associations between the sediments and samples. The high degree of sediment variability between the stations as well as within station SW-2 over time made it necessary to look for associations between the sediment structure of a sample and invertebrate community structure. That is, to determine if sediment-invertebrate community structure was tightly enough linked that community structure could be determined solely on the sediment structure of the sample. Discrete multivariate comparisons of categorized groupings showed no significant associations between sediment structure and community structure. This should not be interpreted to imply that no association exists. The earlier discussions of various functional groups did develop the concept of functional associations, but the results of the cluster analysis point to no general response to the sediment composition by the community as a unit. The various species involved in the system act independently of one another in their responses to the ambient conditions.

The clusters can also be used to distinguish patterns within the clustered samples. The sediment cluster (Figure 1) can be subdivided into three clusters at the similarity level of 0.55. The samples which make up the first cluster consist of SW-2 samples exclusively, and the third cluster is comprised of two samples from SW-2 taken in July. The second cluster contains all of the SW-1 samples as well as most of the October SW-2 samples. This indicates that the samples from SW-2 are much more variable than those from SW-1, and that the October SW-2 samples did converge towards the sediment distribution typical of the upstream site, SW-1. This interpretation confirms the earlier discussion of sediment size structure, with an additional observation that two of the July samples from SW-2 (sample #'s 1 and 2) were quite different from those taken from the same site in July and February.

The benthic invertebrate cluster (Figure 2) is more difficult to interpret. In general the July samples from SW-1 and SW-2 tend to be quite similar and the SW-2 February samples tend to also fall within this cluster. However the samples from SW-1 in February are very different from the patterns found at that station during the other two sampling periods. Since the samples all fall in a single discrete cluster, a seasonal succession in the community structure at SW-1 is implied. Such dynamics are not as

Table XI. Correlation matrix of percent sediment composition.

| July 1985 SW-1 1 | July 1985 SW-1 2 | July 1985 SW-1 3 | July 1985 SW-1 4 | July 1985 SW-2 1 | July 1985 SW-2 2 | July 1985 SW-2 3 | July 1985 SW-2 4 | October 1985 SW-1 1 | October 1985 SW-1 2 | October 1985 SW-1 3 | October 1985 SW-1 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | | | | | | | | | | | |
| 0.984 | 1.000 | | | | | | | | | | |
| 0.998 | 0.992 | 1.000 | | | | | | | | | |
| 0.987 | 0.961 | 0.976 | 1.000 | | | | | | | | |
| 0.685 | 0.802 | 0.728 | 0.622 | 1.000 | | | | | | | |
| 0.288 | 0.445 | 0.347 | 0.212 | 0.869 | 1.000 | | | | | | |
| -0.129 | -0.059 | -0.137 | -0.021 | 0.126 | 0.216 | 1.000 | | | | | |
| -0.137 | 0.032 | -0.090 | -0.157 | 0.567 | 0.803 | 0.639 | 1.000 | | | | |
| 0.945 | 0.981 | 0.954 | 0.936 | 0.845 | 0.523 | 0.130 | 0.188 | 1.000 | | | |
| 0.994 | 0.985 | 0.997 | 0.964 | 0.717 | 0.335 | -0.207 | -0.127 | 0.935 | 1.000 | | |
| 0.999 | 0.983 | 0.996 | 0.992 | 0.680 | 0.282 | -0.101 | -0.133 | 0.948 | 0.990 | 1.000 | |
| 0.923 | 0.959 | 0.929 | 0.929 | 0.827 | 0.508 | 0.188 | 0.190 | 0.986 | 0.906 | 0.930 | 1.000 |
| -0.176 | -0.012 | -0.135 | -0.177 | 0.519 | 0.745 | 0.701 | 0.982 | 0.152 | -0.175 | -0.167 | 0.184 |
| 0.994 | 0.998 | 0.998 | 0.974 | 0.759 | 0.387 | -0.091 | -0.035 | 0.970 | 0.993 | 0.993 | 0.946 |
| 0.888 | 0.913 | 0.886 | 0.920 | 0.738 | 0.415 | 0.337 | 0.202 | 0.965 | 0.850 | 0.900 | 0.965 |
| 0.992 | 0.966 | 0.982 | 0.999 | 0.628 | 0.219 | -0.051 | -0.163 | 0.937 | 0.972 | 0.995 | 0.924 |
| 0.938 | 0.966 | 0.942 | 0.947 | 0.804 | 0.471 | 0.190 | 0.164 | 0.992 | 0.917 | 0.945 | 0.995 |
| 0.998 | 0.970 | 0.991 | 0.991 | 0.635 | 0.225 | -0.143 | -0.197 | 0.925 | 0.987 | 0.998 | 0.907 |
| 0.998 | 0.994 | 0.999 | 0.982 | 0.730 | 0.347 | -0.099 | -0.075 | 0.962 | 0.994 | 0.997 | 0.942 |
| 0.951 | 0.990 | 0.966 | 0.921 | 0.872 | 0.555 | 0.009 | 0.168 | 0.990 | 0.956 | 0.949 | 0.964 |
| -0.172 | -0.004 | -0.125 | -0.189 | 0.535 | 0.795 | 0.646 | 0.998 | 0.154 | -0.162 | -0.167 | 0.158 |
| 0.998 | 0.978 | 0.993 | 0.993 | 0.661 | 0.252 | -0.108 | -0.158 | 0.939 | 0.987 | 0.999 | 0.924 |
| -0.113 | -0.015 | -0.108 | -0.021 | 0.246 | 0.355 | 0.987 | 0.750 | 0.178 | -0.175 | -0.084 | 0.229 |
| 0.113 | 0.219 | 0.121 | 0.185 | 0.462 | 0.504 | 0.937 | 0.782 | 0.403 | 0.055 | 0.136 | 0.444 |

| October 1985 SW-2 1 | October 1985 SW-2 2 | October 1985 SW-2 3 | October 1985 SW-2 4 | February 1986 SW-1 1 | February 1986 SW-1 2 | February 1986 SW-1 3 | February 1986 SW-1 4 | February 1986 SW-2 1 | February 1986 SW-2 2 | February 1986 SW-2 3 | February 1986 SW-2 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | | | | | | | | | | | |
| -0.079 | 1.000 | | | | | | | | | | |
| 0.186 | 0.905 | 1.000 | | | | | | | | | |
| -0.190 | 0.979 | 0.912 | 1.000 | | | | | | | | |
| 0.148 | 0.957 | 0.980 | 0.942 | 1.000 | | | | | | | |
| -0.230 | 0.984 | 0.876 | 0.995 | 0.923 | 1.000 | | | | | | |
| -0.113 | 0.999 | 0.903 | 0.987 | 0.954 | 0.991 | 1.000 | | | | | |
| 0.118 | 0.978 | 0.919 | 0.926 | 0.968 | 0.928 | 0.968 | 1.000 | | | | |
| 0.980 | -0.070 | 0.173 | -0.195 | 0.131 | -0.231 | -0.110 | 0.132 | 1.000 | | | |
| -0.188 | 0.989 | 0.893 | 0.996 | 0.939 | 0.999 | 0.995 | 0.940 | -0.193 | 1.000 | | |
| 0.801 | -0.057 | 0.357 | -0.048 | 0.225 | -0.134 | -0.071 | 0.070 | 0.754 | -0.096 | 1.000 | |
| 0.816 | 0.174 | 0.550 | 0.161 | 0.440 | 0.082 | 0.156 | 0.307 | 0.778 | 0.121 | 0.970 | 1.000 |

Table XII. Correlation matrix of the benthic communities.

| July 1985 SW-1 1 | July 1985 SW-1 2 | July 1985 SW-1 3 | July 1985 SW-1 4 | July 1985 SW-2 1 | July 1985 SW-2 2 | July 1985 SW-2 3 | July 1985 SW-2 4 | October 1985 SW-1 1 | October 1985 SW-1 2 | October 1985 SW-1 3 | October 1985 SW-1 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | | | | | | | | | | | |
| 0.718 | 1.000 | | | | | | | | | | |
| 0.987 | 0.729 | 1.000 | | | | | | | | | |
| 0.966 | 0.762 | 0.986 | 1.000 | | | | | | | | |
| 0.958 | 0.786 | 0.980 | 0.990 | 1.000 | | | | | | | |
| 0.941 | 0.875 | 0.959 | 0.967 | 0.983 | 1.000 | | | | | | |
| 0.976 | 0.752 | 0.997 | 0.990 | 0.989 | 0.971 | 1.000 | | | | | |
| 0.927 | 0.861 | 0.957 | 0.958 | 0.960 | 0.973 | 0.962 | 1.000 | | | | |
| 0.942 | 0.779 | 0.966 | 0.983 | 0.985 | 0.967 | 0.976 | 0.956 | 1.000 | | | |
| 0.934 | 0.849 | 0.960 | 0.969 | 0.979 | 0.983 | 0.969 | 0.980 | 0.983 | 1.000 | | |
| 0.612 | 0.953 | 0.637 | 0.645 | 0.698 | 0.808 | 0.665 | 0.789 | 0.684 | 0.765 | 1.000 | |
| 0.946 | 0.845 | 0.973 | 0.969 | 0.979 | 0.987 | 0.979 | 0.994 | 0.970 | 0.986 | 0.782 | 1.000 |
| 0.956 | 0.802 | 0.977 | 0.992 | 0.998 | 0.984 | 0.986 | 0.965 | 0.988 | 0.985 | 0.702 | 0.979 |
| 0.692 | 0.539 | 0.761 | 0.689 | 0.690 | 0.697 | 0.755 | 0.794 | 0.679 | 0.725 | 0.575 | 0.780 |
| 0.731 | 0.504 | 0.798 | 0.729 | 0.725 | 0.711 | 0.789 | 0.807 | 0.718 | 0.748 | 0.519 | 0.797 |
| 0.372 | 0.352 | 0.449 | 0.351 | 0.363 | 0.404 | 0.443 | 0.527 | 0.352 | 0.427 | 0.474 | 0.501 |
| 0.230 | 0.158 | 0.302 | 0.190 | 0.192 | 0.222 | 0.288 | 0.360 | 0.185 | 0.252 | 0.290 | 0.541 |
| 0.012 | -0.060 | 0.084 | -0.032 | -0.034 | -0.013 | 0.067 | 0.136 | -0.038 | 0.024 | 0.089 | 0.332 |
| 0.466 | 0.265 | 0.539 | 0.437 | 0.432 | 0.430 | 0.523 | 0.559 | 0.425 | 0.468 | 0.346 | 0.104 |
| 0.140 | 0.027 | 0.216 | 0.104 | 0.099 | 0.111 | 0.199 | 0.261 | 0.094 | 0.151 | 0.156 | 0.231 |
| 0.849 | 0.791 | 0.902 | 0.866 | 0.884 | 0.910 | 0.909 | 0.948 | 0.869 | 0.913 | 0.796 | 0.946 |
| 0.942 | 0.737 | 0.982 | 0.967 | 0.972 | 0.954 | 0.985 | 0.969 | 0.960 | 0.962 | 0.677 | 0.980 |
| 0.935 | 0.684 | 0.957 | 0.967 | 0.969 | 0.930 | 0.962 | 0.907 | 0.983 | 0.956 | 0.580 | 0.929 |
| 0.958 | 0.705 | 0.985 | 0.989 | 0.989 | 0.953 | 0.989 | 0.940 | 0.984 | 0.966 | 0.606 | 0.960 |

| October 1985 SW-2 1 | October 1985 SW-2 2 | October 1985 SW-2 3 | October 1985 SW-2 4 | February 1986 SW-1 1 | February 1986 SW-1 2 | February 1986 SW-1 3 | February 1986 SW-1 4 | February 1986 SW-2 1 | February 1986 SW-2 2 | February 1986 SW-2 3 | February 1986 SW-2 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | | | | | | | | | | | |
| 0.681 | 1.000 | | | | | | | | | | |
| 0.715 | 0.992 | 1.000 | | | | | | | | | |
| 0.352 | 0.915 | 0.871 | 1.000 | | | | | | | | |
| 0.418 | 0.840 | 0.798 | 0.977 | 1.000 | | | | | | | |
| 0.179 | 0.697 | 0.654 | 0.904 | 0.972 | 1.000 | | | | | | |
| -0.048 | 0.945 | 0.932 | 0.966 | 0.957 | 0.822 | 1.000 | | | | | |
| 0.085 | 0.785 | 0.751 | 0.941 | 0.989 | 0.990 | 0.938 | 1.000 | | | | |
| 0.879 | 0.923 | 0.916 | 0.744 | 0.601 | 0.397 | 0.751 | 0.506 | 1.000 | | | |
| 0.968 | 0.829 | 0.858 | 0.547 | 0.399 | 0.185 | 0.621 | 0.315 | 0.947 | 1.000 | | |
| 0.972 | 0.651 | 0.704 | 0.310 | 0.157 | -0.055 | 0.410 | 0.078 | 0.825 | 0.944 | 1.000 | |
| 0.987 | 0.713 | 0.760 | 0.379 | 0.225 | 0.010 | 0.477 | 0.145 | 0.871 | 0.977 | 0.988 | 1.000 |

Figure I

Sediment cluster

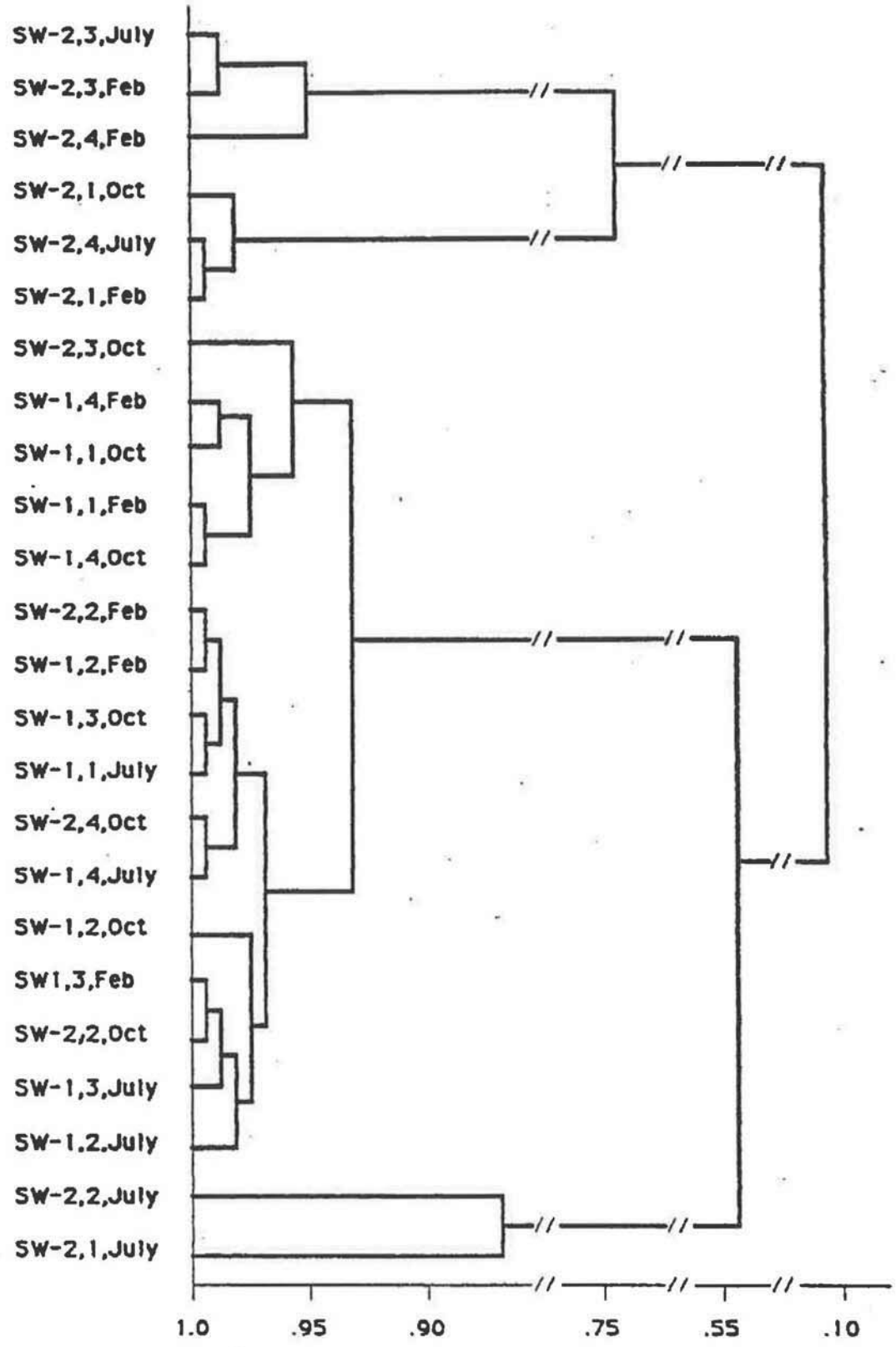
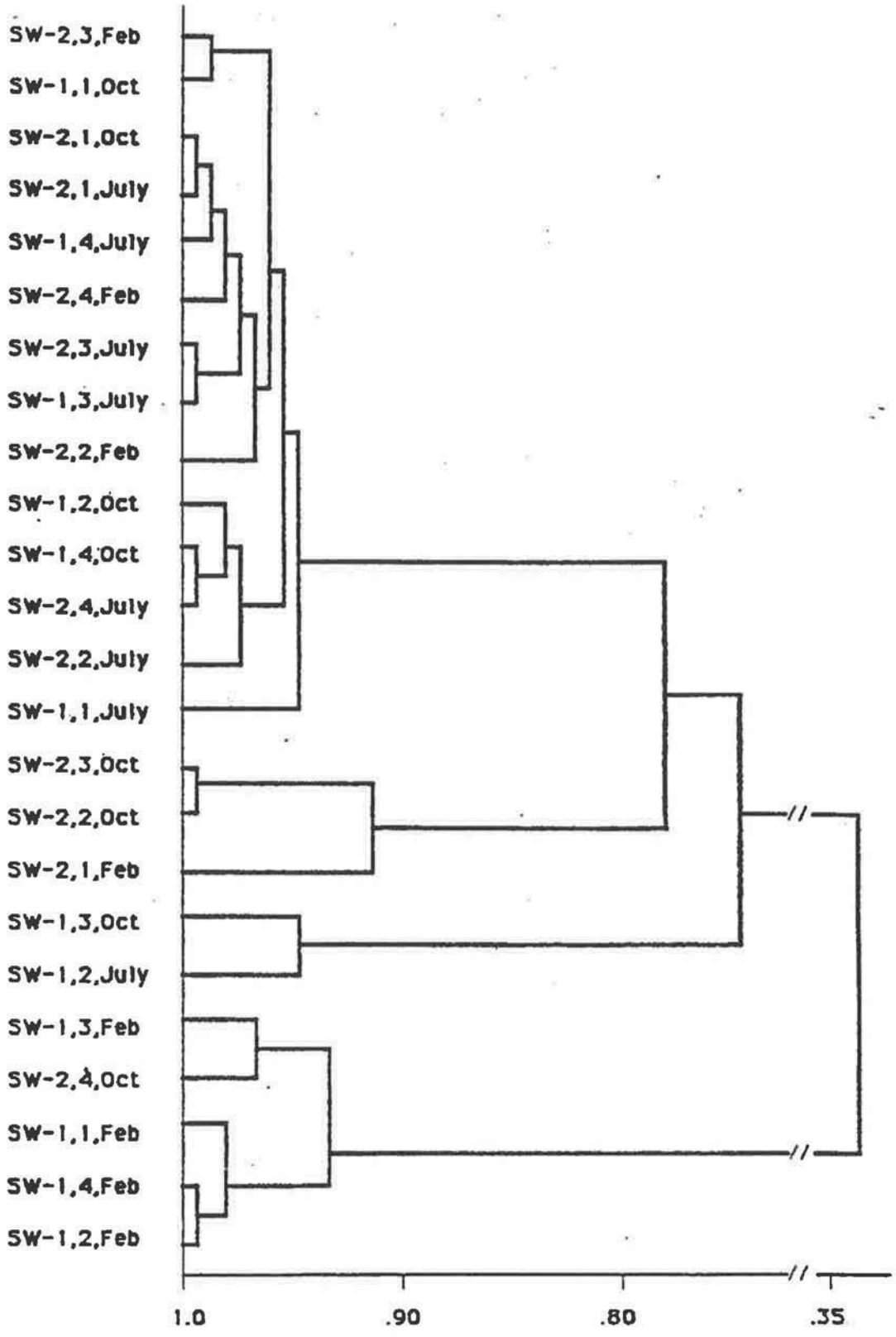

SW-2,3,July
SW-2,3,Feb
SW-2,4,Feb
SW-2,1,Oct
SW-2,4,July
SW-2,1,Feb
SW-2,3,Oct
SW-1,4,Feb
SW-1,1,Oct
SW-1,1,Feb
SW-1,4,Oct
SW-2,2,Feb
SW-1,2,Feb
SW-1,3,Oct
SW-1,1,July
SW-2,4,Oct
SW-1,4,July
SW-1,2,Oct
SW1,3,Feb
SW-2,2,Oct
SW-1,3,July
SW-1,2,July
SW-2,2,July
SW-2,1,July
1.0
.95
.90
.75
.55
.10

Figure II

Benthic community cluster


SW-2,3,Feb
SW-1,1,Oct
SW-2,1,Oct
SW-2,1,July
SW-1,4,July
SW-2,4,Feb
SW-2,3,July
SW-1,3,July
SW-2,2,Feb
SW-1,2,Oct
SW-1,4,Oct
SW-2,4,July
SW-2,2,July
SW-1,1,July
SW-2,3,Oct
SW-2,2,Oct
SW-2,1,Feb
SW-1,3,Oct
SW-1,2,July
SW-1,3,Feb
SW-2,4,Oct
SW-1,1,Feb
SW-1,4,Feb
SW-1,2,Feb
1.0
.90
.80
.35

clear from station SW-2, likely because of the sediment variability over time which complicates interpretation of any existing trends.

## Conclusions

The data gathered for this study have not yielded discrete answers to the impact or degree of impact of the Trail Mountain Coal Company Mining operation on Cottonwood Creek but an evaluation of the various analytical methods used do allow a conclusion to be reached. The general trends shown by the diversity values and the biotic index do point towards some impact on the downstream station, however that impact, if real, is minor. Additional factors need to be considered. 1) Sediment analysis showed that the lower station underwent greater seasonal changes than did the upper station. It is significant that the predominant sediment type at SW-2 was gravel. This substrate size is less stable than the rubble habitat found at station SW-1, and thus the differences seen between SW-1 and SW-2 communities could be a function of the sediment structure and completely independent of any mining impact. 2) It is also notable that in February the diversity value at SW-1 was actually lower than that at SW-2, implying that if diversity alone were the judgement tool, SW-2 at that time was in better condition than is the upstream SW-1. The location of a road paralleling Cottonwood Creek above SW-1 will also stress the stream independently of the Trail Mountain Mining operation. 3) Observations made when sampling began in July included the presence of a calcarious marl in the sediments at SW-2. Whether sampling sufficiently disturbed this marl and thus initiated the shift in sediment structure observed in October is not known, but must be retained as a possibility. 4) The degree of development of various functional groups differed between the two sites. In particular the filter feeders and grazers are strongly influenced by substrate size since unstable substrates have a lower standing crop of algae and are not good anchoring sites for filter feeders. Different substrate sizes will also influence the settling and retention of different sizes of detrital particles and thus influence the densities and species composition of the shredder groups in the substrate.

In general the differences between the two stations can be sufficiently explained by differences in sediment structure. The higher biotic index values of SW-2, while consistently above that of SW-1, are associated with the microhabitat created in a gravel environment as opposed to a rubble area. The benthic inhabitants of gravel tend to be those which have been given higher biotic index values. This relates to their ability to live under less turbulent (and thus less oxygenated) conditions. The biotic index does not consider variations in substrate type, other than assuming that samples will be taken from the most coarse substrate available. This results in an index which is robust and more reliable than diversity indices, but which can confound the effects of sediment structure and thus give biased results.

Therefore I am concluding that the impact of the Trail Mountain mining operation on the Cottonwood Creek invertebrate community is negligible as determined by the prescribed sampling program. Because of various confounding factors unanticipated in the original design of the study, a more direct conclusion is not possible. It does not appear that additional studies

need to be conducted, however if further sampling is required I recommend that several changes be made in the prescribed methodology. First, care should be taken to select a downstream station with canopy cover, sediments and slope conditions comparable to that at station SW-1. This will allow the elimination of the marl as a confounding variable. The taking of four replicate samples is often standard, but usually results in too few samples to give strong statistical confidence in the results of the study. More samples should be taken per station. More frequent sampling will allow a more accurate assessment of seasonal events, and in some ways reduce the extrapolation necessary to interpret results, but monthly sampling is probably not necessary. It also appears that winter samples may not be as useful as samples taken during the warmer months.

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APPENDIX 7-13

AGENCY APPROVALS FOR CULVERT EXTENSION

APPENDIX 7-13
PROPOSED CULVERT EXTENSION

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by T. Munson date 11/13/90

9/24/90

AMENDMENT TO
APPROVED
Approved
Reclamation Plan
Gas & Mining
by
date

**APPENDIX 7-13**

**TRAIL MOUNTAIN NO. 9 MINE**

**PROPOSED CULVERT EXTENSION**

General

The proposed project consists of extending the existing 66" culvert approximately 300' up Cottonwood canyon. This extension will allow the expansion of the parking and storage area at the site and eliminate the situation of having the mine operation adjacent to an open perennial stream channel.

The additional room is needed to facilitate the transfer of all personnel from the Gordon Creek No. 8 Mine, which is due to close around the end of October, 1990. It will also allow for placement of a new bath house north of the main office building.

The proposed plan includes burial of the culvert with material trimmed from the highwall to the west, and from regrading of the storage yard. The existing 96" to 66" transition will be moved to the new inlet location. The existing headwall and wingwall configuration will be duplicated, and the existing trash rack will be placed at the new inlet.

The location of the proposed extension and cross-sections of the area are shown on the enclosed Figures 7-21 and 7-22.

Disturbed Area Increase

The proposed project will increase the existing disturbed area of 8.80 acres by approximately 0.471 acres. This, coupled with the proposed disturbed area increase of 0.340 acres at the proposed new ventilation portal, will result in a total increase of 0.811 acres or 9.22% of the existing disturbed area.

Installation Procedure

The culvert installation will take place in the following manner:

(1) A check dam will be constructed upstream of the proposed new inlet, to capture flow from the stream;

(2) A 5 HP (or larger) pump will be placed in the check dam, and will divert the stream flow through a line running under the road and down the east road ditch to the 36" cmp drop drain. This drain flows into the 66" culvert;

(3) An emergency overflow will be constructed in the check dam to direct major drainage through the construction area and back into the existing culvert. This overflow would impact the construction; however, it would only be used during a major storm event. Details of the proposed diversion structures are shown on the attached "Diversion Structures" drawing;

(4) Once the stream diversion is complete, the trash rack, rip-rap and headwall structures will be removed using a track-mounted backhoe. The concrete will be broken up and hauled to an approved landfill. The rip-rap and trash rack will be stored for re-use;

(5) The 96" to 66" transition will be removed next. This piece will also be stored for re-use;

(6) Vegetation will then be removed and hauled to an approved disposal site; (Note A raptor survey will be completed prior to such removal. Any existing nests will only be removed in accordance with regulations, and with proper approval.)

(7) Topsoil will be removed land placed on the existing topsoil storage pile; Salvageable material (at least the top 12")or greater will also be removed from the vegetation test plots and placed on the topsoil pile;

(8) The channel area will then be regraded in preparation for placement of the culvert;

(9) A bedding of not less than 12" of sand will be placed in the bottom of the channel, and smoothed for placement of the culvert;

(10) The culvert will then be installed up to and including the inlet transition;

(11) Equipment (dozer and/or backhoe) will then start trimming the west side highwall and generating fill material for the culvert. Rocks larger than 12" diameter will not be placed into the culvert backfill, and care will be taken to avoid any large rocks being placed next to the culvert;

(12) The backfill material will be mechanically tamped along the culvert in lifts not to exceed 6". The mechanical tamping will continue until the culvert is more than 1/2 buried;

(13) The backfilling will be completed and the yard will be regraded to the final configuration. A berm will be placed along the east edge of the disturbance to direct runoff to the concrete ditch below;

(14) The concrete inlet and wingwalls will be poured as soon as the culvert is placed to allow curing. The trash rack and rip-rap protection will be installed as a final step.

(15) The check dam and pump will be removed. The fence will be extended, and new disturbed area perimeter markers will be installed.

Environmental Considerations

1- Disturbed Area

The project will disturb an area of approximately 0.471 acres of riparian habitat. Mitigation for this loss of riparian area is discussed later in this section. The highwall trimming and yard regrading will take place within the disturbed area perimeter.

2- Drainage Controls

a. Description - Drainage controls for this project will consist of temporary diversion measures described above. In addition, permanent drainage controls will be installed. These will consist of:

(1) The extended culvert;

(2) Installation of a berm along the disturbed area perimeter to direct drainage to the concrete ditch and sediment pond;

(3) Regrading of the storage and parking areas to drain to the berm and concrete ditch.

b. Additional Drainage - The additional drainage area to the sediment pond is shown on Figure A-7-2. This consists of approximately 0.471 acres of additional disturbed area. Runoff from this area is calculated based on the 10 year - 24 hour event. Details of the calculations are shown in the enclosed tables, and the entire sediment pond requirements are summarized in Chapter 7 of the M.R.P..

c. Map - Drainage controls are shown on the enclosed map Figure A-7-2 and on Figure 7-11 of the M.R.P..

d. Controls - Drainage controls for the culvert inlet will consist of concrete wingwalls, a trash rack, and 18" + D50 rip-rap. Yard drainage will be controlled by a berm at least 24" high along the eastern edge of the disturbed area.

e. Calculations - Calculations for all hydrologic control structures for this project are included in this Appendix.

3- Topsoil - The proposed disturbance is in the riparian area, designated as soil type R-1 in Chapter 9 of the M.R.P.. The stream bank area is extremely steep and rocky; however, some topsoil can likely be salvaged by the use of a backhoe. It is estimated that an average depth of 16" of topsoil can be salvaged over 50% of the area, resulting in approximately 200 cubic yards of topsoil to be saved. Any recovered topsoil will be placed in an uncompacted state on the existing topsoil pile and reseeded. As previously mentioned, the top 12" (or more) of the vegetation test plot material will also be saved and placed on the topsoil pile.

4- Vegetation - All large, woody vegetation will be removed from the area prior to salvage of topsoil. Smaller specimens (less than 12" diameter) will be mixed with the topsoil to provide organic material. Upon completion of the project, the trimmed highwall and the newly stored topsoil will be reseeded using the approved seed mix and methodology for contemporaneous reclamation.

5- Wildlife - Since this project will remove approximately 0.471 acres of riparian habitat, mitigation measures have been developed in consultation with the DWR. The mitigation proposed is the installation of 20 small rock

check dams in the lower 1.3 miles of Cottonwood Creek. These structures will be placed to facilitate water retention and enhance the possibility of fish survival in this area. A complete description of the proposed mitigation project submitted to DWR is shown in Attachment I of the appendix.

Impact to macroinvertabrates are expected to be negligible based on the study in Appendix 10-7 of the M.R.P..

Other potential impacts would be in the form of nests in the trees along the stream. A raptor survey of the area will be conducted prior to disturbance, and any necessary approvals or mitigation measures will be completed prior to construction.

No other impacts to wildlife are expected as a result of this project. In fact, the removal of the open stream next to an operations area may actually have a positive effect on water quality.

6- Dust Control - If dust should become a problem during construction the area will be watered as necessary. Upon completion of regrading, the parking land storage area will be graveled to reduce dust. The area will also be sprinkled or otherwise treated to minimize fugitive dust from the operation.

7- Cultural/Historical/Archaeological Sites - This area is not known to contain any sites of cultural, historical or archaeological significance. (See Chapter 5 of the M.R.P. for studies and results).

Operations Plan

The culvert extension will facilitate much needed expansion of parking and storage areas, and allow for placement of a new bathhouse necessitated by transfer of personnel from the closing Gordon Creek operations. This extension is expected to last the life of the operation, and all controls and protection devices will be maintained to ensure the systems operate as designed.

Reclamation Plan

Upon completion of operations, this area will be reclaimed in conjunction with the rest of the site. The culverts and all associated structures will be removed, the area will be upgraded, and the channel will be restored as described in Sections 3.5 and 7.4 of the M.R.P. The channel area will be restored according to the "Typical Reclaimed Channel" design shown in Figure 7-20 of the M.R.P.. For clarification, this typical reclaimed section is also shown on the cross-sections (Figure A-7-22) of this Appendix.

Upon completion of recontouring, the areas will be reseeded per the approved plan for permanent reclamation. In addition, Beaver Creek

Coal Co. will commit to transplanting 100 ten-gallon and 25 twenty-five gallon Cottonwood Trees per acre in the riparian area. Topsoil from the topsoil storage pile will be used for reclamation of the riparian zone, due to the low salt tolerance of most riparian vegetation.

Other Agency Approvals Required

Since this proposal involves a perennial stream and riparian area, approvals must be obtained from the State Engineer's Office and the Division of Wildlife Resources. Required forms and plans have been submitted to each of the agencies, and are included in Attachment I of this Appendix.

Construction Schedule

It is proposed to do this project during the late fall of this year, since this time not only coincides with the company's needs, but it is also the period of lowest flow in the stream.

It is planned to start the culvert installation between Oct. 15 and Nov. 1, 1990 and complete the project within approximately 3 weeks.

Bond Revision

Calculations for the increase in the Reclamation Bond required for this project are shown in the attached table "Reclamation Bond Increase". Since this is only one of several projects impacting the bond, the numbers from this Appendix are incorporated with all others and presented in the main "Surety Bond Estimate", Table 3-3 of the M.R.P..

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

**CALCULATIONS**

**for**

**Proposed Culvert Extension**

The culvert extension calculations follow the same methodology used in the original calculations in Appendix 7-3 of the M.R.P.

The following is a list of criteria and formulas used for these calculations:

(1) Friction loss was calculated using the Darcy-Weisbach equation:

$$H_f = f \frac{L}{D} \frac{V^2}{2g} ;$$

where $H_f$ = Head loss in feet due to friction;

$f$ = friction factor

$L$ = Length of pipe in feet

$D$ = Average inside diameter of pipe in feet

$V$ = Average pipe velocity in fps

$g$ = Gravitational constant (32.174 $ft/sec^2$)

Note: Friction factors are the same as used in original calculations. These were checked against the Moody Diagram, p. 3-11 "Cameron Hydraulic Data", Ingersol - Rand Co., 1984.

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

(2) Minor Loses

| | K | Head Loss ($H_L$) |
|---|---|---|
| Entrance loss | 0.25 | $H_L = 0.25 \frac{V_1}{2g}$ |
| Contraction | 0.11 | |
| Bends (2@ .08) | 0.16 | |
| Exit Loss | 1.00 | |
| Total = | 1.27 | $H_L = 1.27 \frac{V_2}{2g}$ |

(3) Velocities

$V_1$ = Velocity @ 96" inlet @ 510 cfs = 10.15 fps
$V_2$ = Velocity in 66" pipe @ 510 cfs = 21.47 fps
$V_3$ = Velocity in 96"-66" transition @ 510 cfs = 15.37 fps

(4) Friction Factors

$f_1$ = Friction factor for transition = 0.044
$f_2$ = Friction factor for 66" culvert = 0.047

(5) Culvert Specs.

| | | |
|---|---|---|
| (a) | Headwall | - 11 ft. |
| (b) | Inlet Elev. | - 7310 |
| (c) | Outlet Elev. | - 7174 |
| (d) | Culvert Length (Total) | - 1860' |
| (e) | 66" Culvert Length | - 1822' |
| (f) | 96" - 66" Transition | - 38' |
| (g) | Avg. Culvert Slope | - 7.78% |

Verification of 510 cfs Capacity

Q = 510 cfs

$V_1 = \frac{510}{50.27} = 10.15$ fps; $V_2 \frac{510}{23.76} = 21.47$ fps

$V_3$ = Velocity in 96" to 66" transition with an average diameter of 6.5'.

$V_3 = \frac{510}{33.18} = 15.37$ fps

9/24/90

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

$$\text{Minor Losses} = 0.25 \frac{(10.15)^2}{64.4} + 1.27 \frac{(21.47)^2}{64.4} = 9.49 \text{ ft.}$$

Major Losses

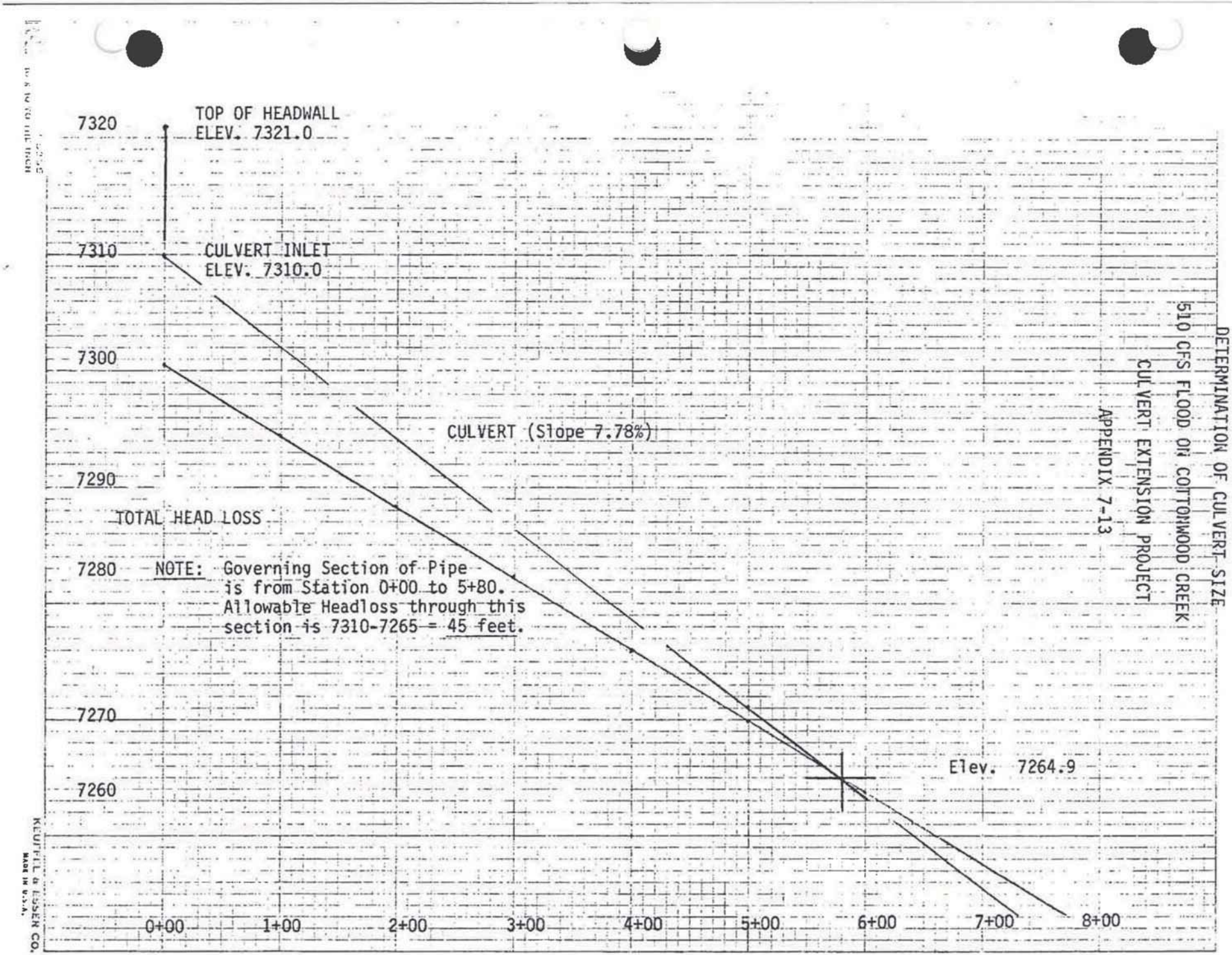
542' of 66" Pipe; $H_L = 0.047 \frac{(542)(21.47)^2}{5.5 \quad 64.4} = 33.15$ ft.

38' of Transition; $H_L = 0.044 \frac{(38)(15.37)^2}{6.5 \quad 64.4} = 0.94$ ft.

TOTAL HEAD LOSS @ 510 cfs = 43.58 ft.

O.K., since it is less than 45 ft. available.

9/24/90


DETERMINATION OF CULVERT SIZE
510 CFS FLOOD ON COTTONWOOD CREEK
CULVERT EXTENSION PROJECT
APPENDIX 7-13
7320
TOP OF HEADWALL
ELEV. 7321.0
7310
CULVERT INLET
ELEV. 7310.0
7300
CULVERT (Slope 7.78%)
7290
TOTAL HEAD LOSS
7280
NOTE: Governing Section of Pipe is from Station 0+00 to 5+80. Allowable Headloss through this section is 7310-7265 = 45 feet.
7270
7260
Elev. 7264.9
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
KEUFFEL & ESSER CO.
MADE IN U.S.A.

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

## Additional Drainage

Calculations

Proposed Culvert Extension Project

| | | |
|---|---|---|
| Disturbed Area (ac.) | - | 0.47 |
| Runoff Curve Number | - | 90 |
| 10 yr. - 24 hr. Precip. (in.) | - | 2.40 |
| 10 yr. - 24 hr. Runoff (in.) | - | 1.40 |
| 25 yr. - 24 hr. Precip. (in.) | - | 2.90 |
| 25 yr. - 24 hr. Runoff (in.) | - | 1.89 |
| Land Slope (%) | - | 3.00 |
| Hydraulic Length (ft.) | - | 300 |
| Time of Conc. (Hrs.) | - | 0.05 |
| Peak Flow -- 10/24 (cfs) | - | 1.03 |
| Peak Flow -- 25/24 (cfs) | - | 1.39 |
| Runoff Volume - 10/24 (ac. ft.) | - | 0.057 |
| Sediment Volume - 10/24 (ac. ft.) | - | 0.024 |
| Additional Pond Volume Req'd (ac. ft.) | - | 0.081 |

9/24/90

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

RECLAMATION BOND INCREASE
PROPOSED CULVERT EXTENSION

| ITEM | MAN/SHIFT | *1 COST/MAN SHIFT | LABOR COST | EQUIPMENT REQUIREMENTS | *2 SHIFT/COST | EQUIPMENT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|
| **Surface Facilities Removal** | | | | | | | |
| Culvert | 1/5 | 160 | 800 | Truck | 5/250 | 1250 | 2050 |
| | 1/5 | 160 | 800 | Crane | 5/381 | 1905 | 2705 |
| | 2/5 | 120 | 1200 | None | - | - | 1200 |
| **Earthwork** | 1/2 | 160 | 320 | Dozer | 2/703 | 1406 | 1726 |
| | 1/4 | 160 | 640 | 988 Loader | 4/971 | 3880 | 4520 |
| | 1/2 | 120 | 240 | Track Excavator | 2/954 | 1908 | 2148 |
| **Rip-Rap** | 1/2 | 160 | 320 | Truck | 2/250 | 500 | 820 |
| | 1/2 | 160 | 320 | Backhoe | 2/225 | 450 | 770 |
| | 1/2 | 120 | 240 | None | - | - | 240 |
| **Revegetation** | | | | | | | |
| Fertilization | 1/1 | 160 | 160 | Dozer | 1/703 | 703 | 863 |
| | | | | Spreader | 1/55 | 55 | 55 |
| | | | | Fertilizer | .471 ac @ $30/ac | 14 | 14 |

10/30/90

Beaver Creek Coal Company
Trail Mountain No. 9 Mine

RECLAMATION BOND INCREASE
PROPOSED CULVERT EXTENSION (continued)

| ITEM | MAN/SHIFT | *1 COST/MAN SHIFT | LABOR COST | EQUIPMENT REQUIREMENTS | *2 SHIFT/COST | EQUIPMENT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|
| **Revegetation (continued)** | | | | | | | |
| Seed Preparation | 1/1 | 160 | 160 | Dozer | 1/703 | 703 | 863 |
| | | | | Spreader | 1/55 | 55 | 55 |
| (Riparian Area) | | | | Fertilizer | 1/55 | 55 | 55 |
| | | | | Disk | 1/55 | 55 | 55 |
| | | | | Harrow | 1/55 | 55 | 55 |
| | | | | Seed | .5 ac @ $ 236/ac. | 118 | 118 |
| Mulch | 10/1 | 120 | 1200 | Erosion Mat. | .471ac @ $1100/ac. | 518 | 1718 |
| Containerized | 2/1 | 120 | 240 | Plant Materials | - | 68 | 308 |
| **Miscellaneous** | | | | | | | |
| Supervision | 1/10 | 200 | 2000 | N/A | N/A | N/A | 2000 |

| | | |
|---|---|---|
| Sub - Total | = | $22,338 |
| +10.00% Contingency | = | 2,234 |
| Total (1984 Dollars) | = | $24,572 |
| +6.78 Inflation (5yrs.) | = | 9,538 |
| Total (1989 Dollars) | = | $34,110 |
| +6.78 Inflation (5yrs.) | = | 13,242 |
| Total (1994 Dollars) | = | $47,352 |

*1- Cost Estimates From: Means 1984 Cost Construction Data, 42nd Annual Edition.

*2- Cost Estimates From: Rental Rate Blue Book - Construction Equipment, 1983.

10/30/90

**ATTACHMENT I**

**OTHER AGENCY APPROVALS**

**FOR**

**CULVERT EXTENSION PROJECT**

RECEIVED

SEP 10 1990

WATER RIGHTS
PRICE

# PERMIT APPLICATION

## TO ALTER A NATURAL CHANNEL IN THE STATE OF UTAH

1 Application Number _____

| Applicant's Name (Last, First, M.I.) | Authorized Agent | Telephone No. & Area Code |
|---|---|---|
| Beaver Creek Coal Co. | Dan W. Guy | (801) 637-5050 |

Address (Street, RFD, Box Number, City, State, Zip)
P.O. Box 1378, Price, Utah 84501

| Quarter Section(s) | Section(s) | Township(s) | Range(s) & Base |
|---|---|---|---|
| * NE1/4SW1/4NE1/4 | Sec 25 | T. 17 S. | R. 6 E. ., SLB&M |

| County | Watercourse to be altered | Drainage Area |
|---|---|---|
| Emery | Cottonwood Creek | Cottonwood Canyon |

Common Description or Address of Proposed Project
Trail Mountain No. 9 Mine, 12 Miles NW of Orangeville, Utah

2 Nature of proposed alteration (Check applicable boxes)

| | | | |
|---|---|---|---|
| [ ] fill | [ ] excavate | [ ] bridge | [X] culvert |
| [ ] remove | [ ] construct | [ ] riprap | [ ] wetland |
| [ ] abandon | [ ] realign | [ ] channel | [ ] obstruction |
| [ ] install | [ ] maintain | [ ] diversion works | [ ] watercourse |
| [ ] bank protection | [X] instream structure | [ ] other _____ | [ ] other _____ |

3 Estimated Cost of Project
$ 25,000 - 30,000

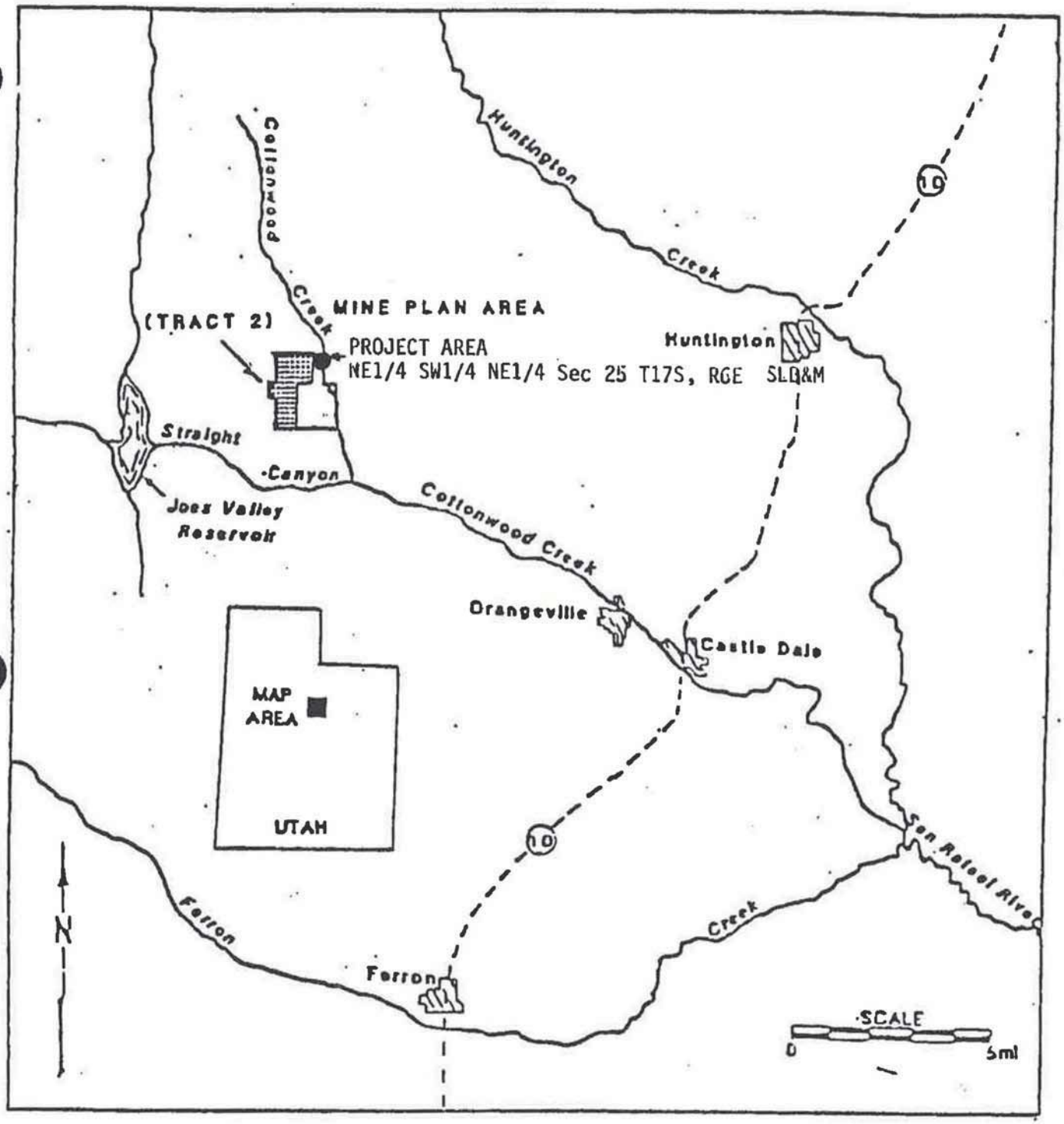
4 Project Plans
Plans included? Yes Number of attachments 1

5 Brief Explanation of Project
Extension of the existing 66" culvert approximately 300' upstream from the present location. The existing concrete headwall and trash rack design will also be replaced at the new inlet, along with the 96" to 66" transition. The present storage/parking area will be expanded through covering of the new culvert.
15 to 20 small rock structures will be installed to hold water in the lower 1.3 miles of Cottonwood Creek. This project is proposed as mitigation for the loss of riparian area above.

6 Justification (Explain why this project is needed)
To allow for the placement of new bath house, storage and parking facilities at the site. The Gordon Creek No. 8 Mine will be completed in the fall of 1990, and in order to maintain coal production and existing employment levels, those people will be moved to the No. 9 Mine. Existing facilities are inadequate to handle the additional people.

7 Detrimental Effects (Anticipated changes to the water and related land resources, including unavoidable detrimental effects)
Loss of approximately 300' of stream channel and a narrow band of riparian area along the channel. Water quality will not be affected, and may improve due to less fugitive dust entering the channel, from the forest service road and the operation.

* Note: Rock dams in Sec. 31, T.17S., R.7E. and Sec. 6, T.18S., R.7E., S.L.B &M.



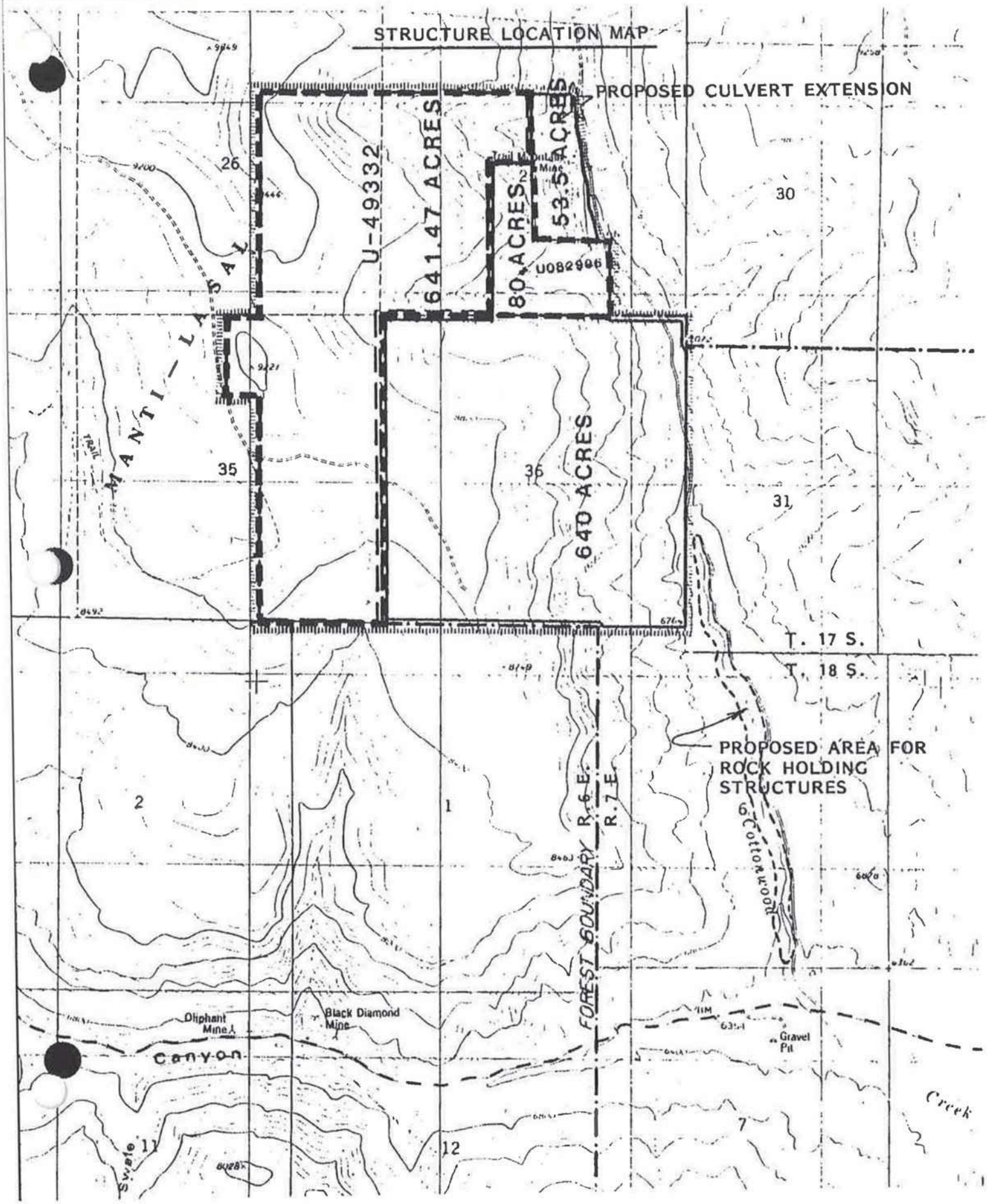

Location of the Trail Mountain Mine Plan Area.

COTTONWOOD CREEK

Culvert Extension Project

FIGURE 1

9/6/90

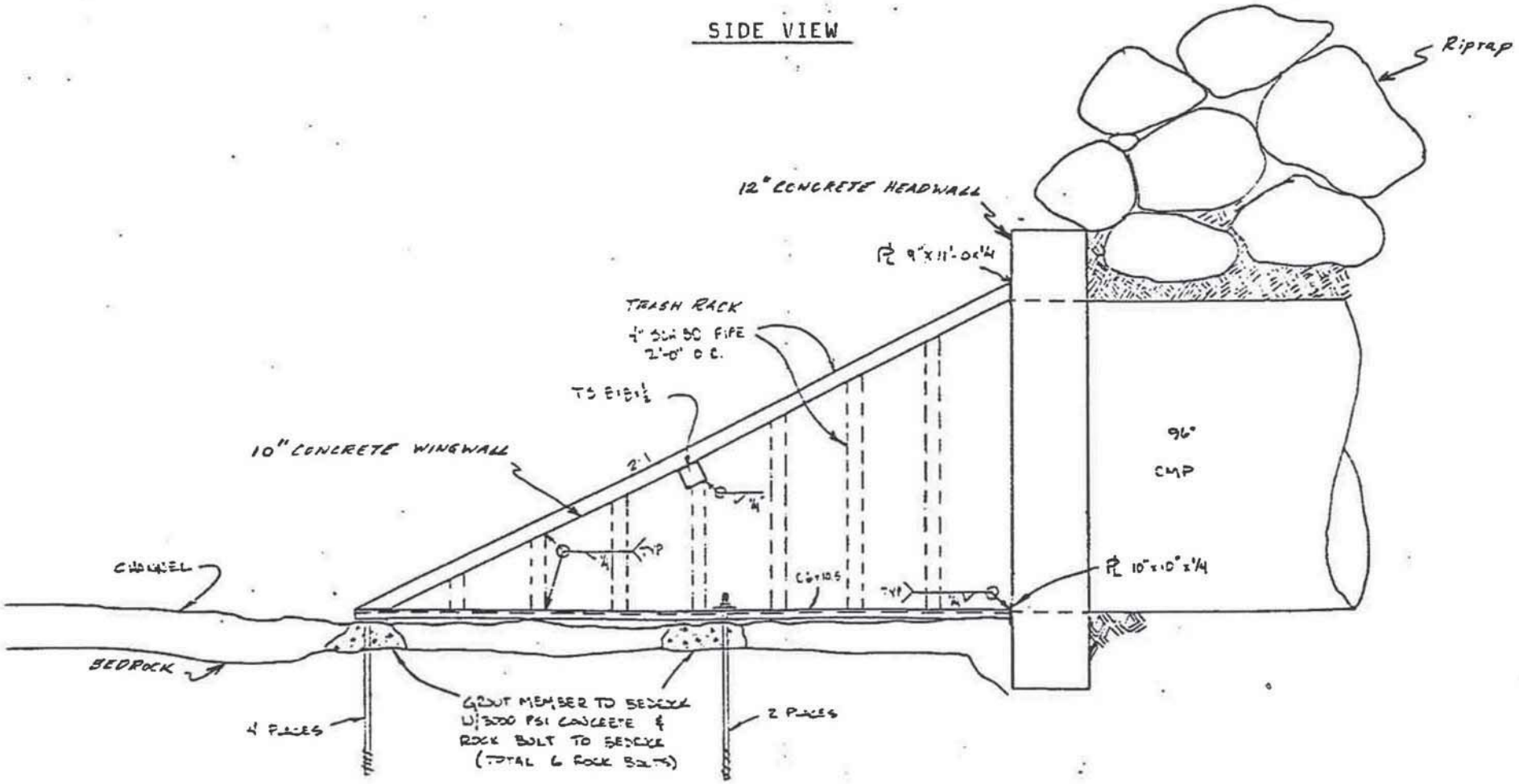

STRUCTURE LOCATION MAP
PROPOSED CULVERT EXTENSION
U-49332
641.47 ACRES
80 ACRES
53.5 ACRES
U082986
640 ACRES
MANTI-LASAL
26
30
35
36
31
T. 17 S.
T. 18 S.
R.6 E.
R.7 E.
FOREST BOUNDARY
PROPOSED AREA FOR ROCK HOLDING STRUCTURES
2
1
6
7
11
12
Cottonwood
Canyon
Oliphant Mine
Black Diamond Mine
Gravel Pit
Creek

BEAVER CREEK COAL COMPANY

COTTONWOOD CREEK CULVERT EXTENSION

CULVERT INLET DESIGN

SIDE VIEW

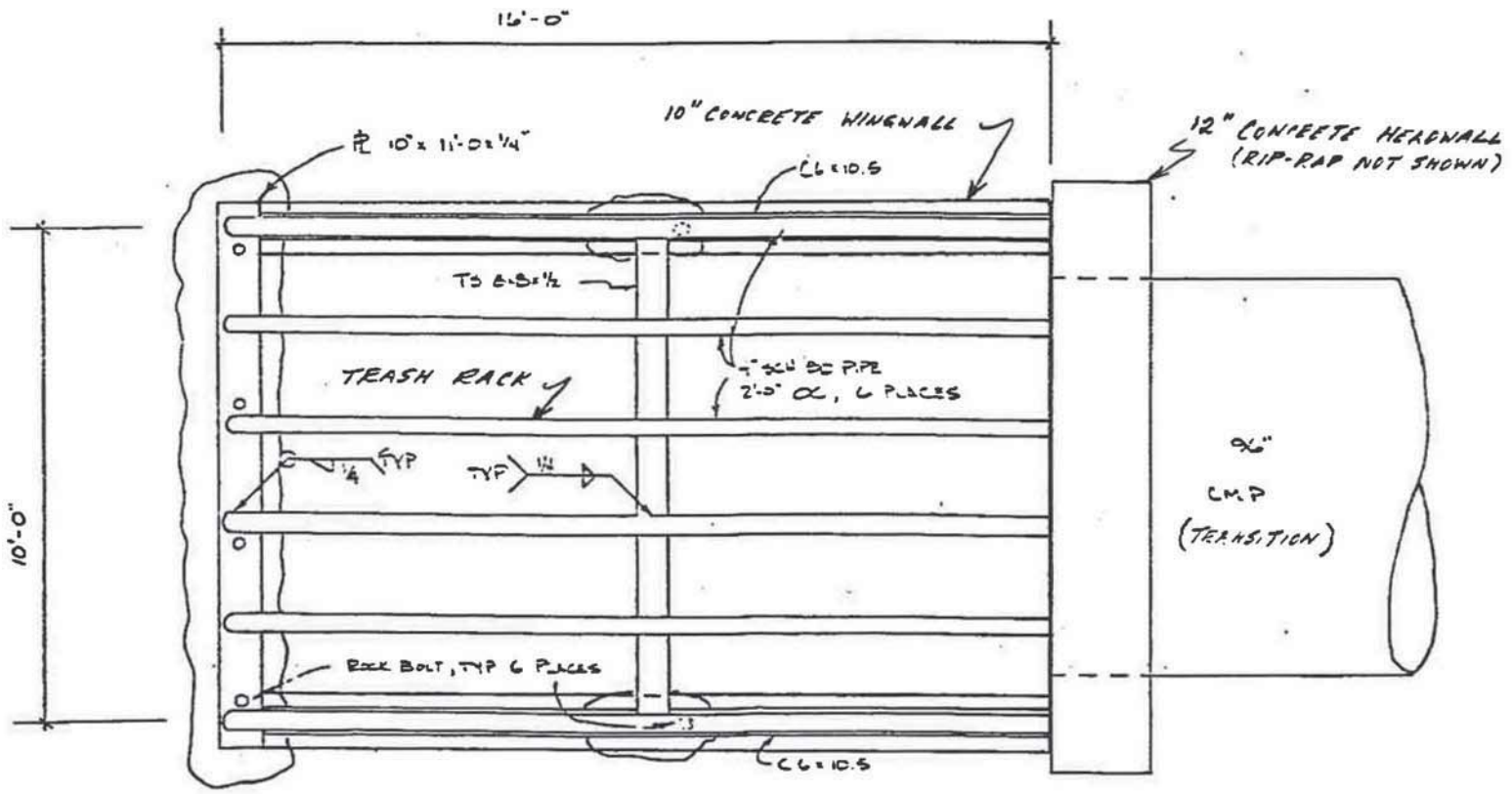


BEAVER CREEK COAL COMPANY

COTTONWOOD CREEK CULVERT EXTENSION

CULVERT INLET DESIGN

PLAN VIEW



**BEAVER CREEK COAL COMPANY MITIGATION PLAN**
**COTTONWOOD CREEK NO. 9 MINE**

Beaver Creek Coal Company has requested an extension of the existing 66" culvert which transversed the No. 9 Mine facility by an additional 300 linear feet.

The need for the extension has been created through the expansion of the No. 9 Mine workings as a result of the imminent closure of their existing No. 8 Mine in the fall of 1990. In order to absorb the present employment at No. 8 Mine and meet contract demands, a number of new and expanded facilities are required at the No. 9 Mine. The extension of the culvert an additional 300' will enable Beaver Creek to increase the size of the existing bath house and utilize a storage and parking area to its fullest capacity. The socioeconomic impacts of the No. 8 Mine closure can thus be avoided through the expansion of the Cottonwood No. 9 Mine facility.

Beaver Creek Coal is cognate of the environmental impacts associated with the extension of the culvert. It appears that a portion of the biotic community in that portion of cottonwood Creek will be lost as well as a narrow band of riparian habitat adjacent to the creek. While this loss is unavoidable, Beaver Creek feels confident that the loss can be mitigated and a net enhancement to Cottonwood Creek should be the ultimate trade off.

To achieve this end, Beaver Creek Coal Company's representative met with Mr. Larry Dalton, Resource Analyst, Utah Division of Wildlife Resources, and Mr. Bill Warmack, Utah State Engineer, Division of Water Rights. The following plan is the result of those discussions.

Cottonwood Creek has a potential to maintain a fishery based on water quality and flow along the lower 1.3 miles of channel. Unfortunately, past efforts to establish trout in this area have met with very limited success. It is felt that the major contributing factor to the lack of success is directly attributed to both the previous 4 years of drought and the resulting low flows in combination with the creek's inherent lack of sufficient water holding structures. While little can be done to compensate for the drought, a great deal can be accomplished to enhance the potential for water holding structures. It is to this goal that Beaver Creek Coal is committed.

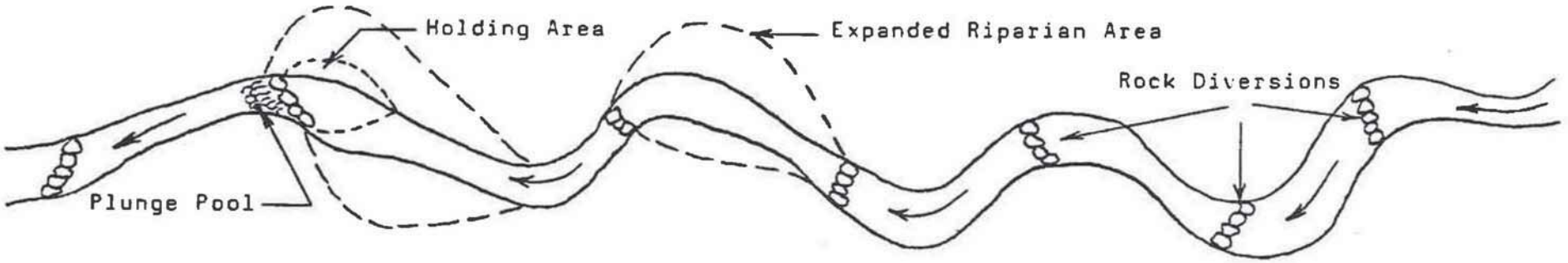
By implementing up to 20 small rock diversions, less than 1' in height and constructed across the creek out of native rock cemented together, a small flood plain and plunge pool can be created. Each of these small structures create a favorable environment for an expanded biotic community, an ecological niche for trout and an enhanced riparian zone. While each structure is

small in size, the collected effect of 20 of these structures is substantial, and should result in a net gain of both riparian zone and biotic community over the loss associated with the culvert extension. Keeping in mind that the area of the culvert extension is too far removed from adequate flows to support a fishery, an overall net gain should be achieved and the creek in total should be benefitted both in the short and long term.

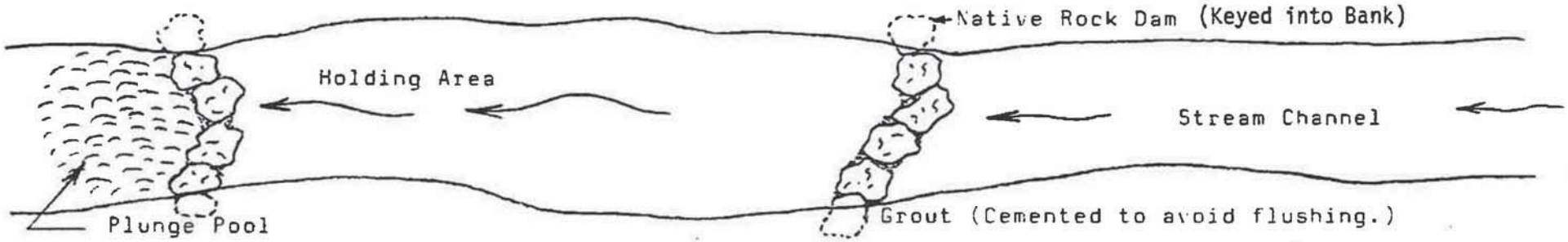
Beaver Creek Coal welcomes additional comments and recommendations from concerned agencies and will strive to incorporate all such requests so that all adverse impacts of this project will be adequately mitigated.

See Figure 1 for conceptual design of stream structures.

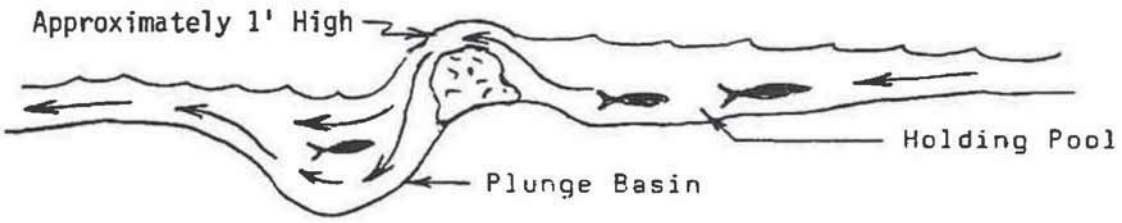
# ROCK HOL G STRUCTURES




COTTONWOOD CREEK - GENERAL

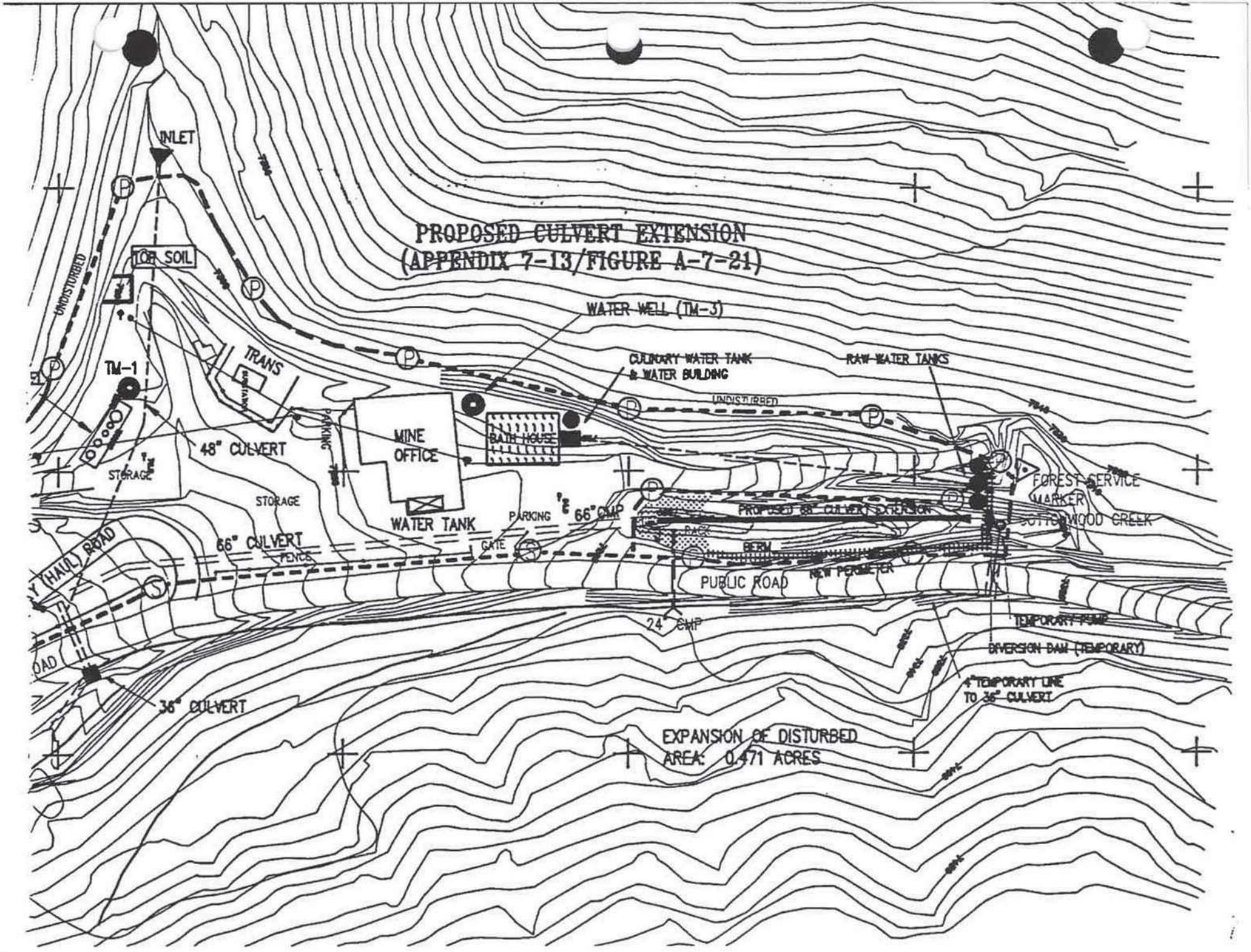



STREAM CHANNEL - DETAIL




PLUNGE POOL - DETAIL

FIGURE 1


PROPOSED CULVERT EXTENSION
(APPENDIX 7-13/FIGURE A-7-21)
INLET
TOP SOIL
UNDISTURBED
TM-1
TRANS
WATER WELL (TM-3)
CULINARY WATER TANK
& WATER BUILDING
RAW WATER TANKS
UNDISTURBED
48" CULVERT
STORAGE
MINE
OFFICE
BATH HOUSE
PARKING
STORAGE
WATER TANK
PARKING
66" CMP
66" CULVERT
FENCE
GATE
PROPOSED 66" CULVERT EXTENSION
BERM
NEW PERIMETER
PUBLIC ROAD
24" CMP
FOREST SERVICE
MARKER
COTTONWOOD CREEK
TEMPORARY PUMP
DIVERSION DAM (TEMPORARY)
4" TEMPORARY LINE
TO 36" CULVERT
36" CULVERT
EXPANSION OF DISTURBED
AREA: 0.471 ACRES

# RAPTOR SURVEY

# NO. 9 MINE

# COTTONWOOD CREEK

BEAVER CREEK COAL COMPANY

Prepared

by

E.I.S.
Melvin A. Coonrod
P.O. Box 358
Elmo, Utah 84521

# Raptor Survey

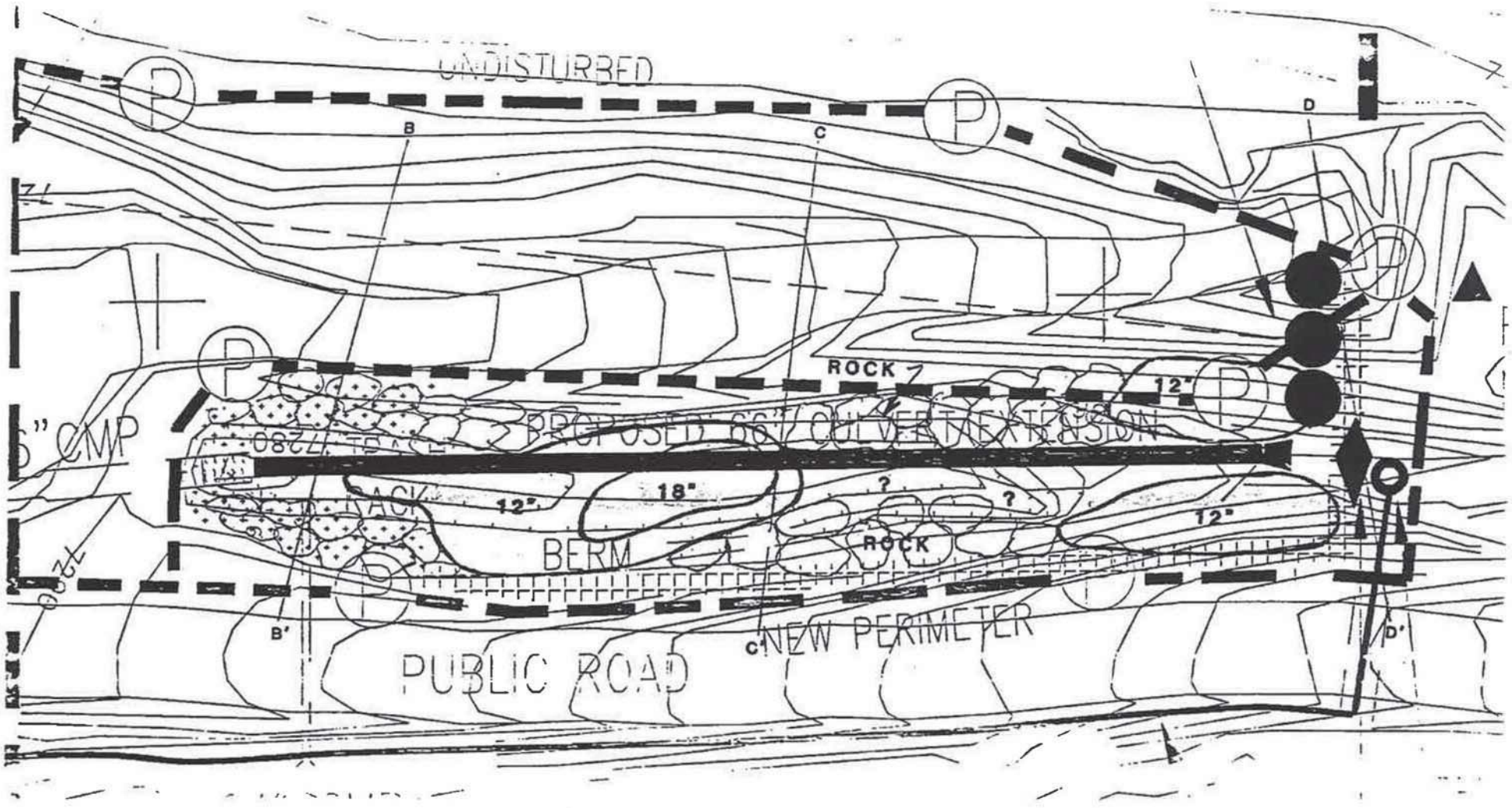
On October 17, 1990, a survey was conducted on 440' of Upper Cottonwood Creek from the confluences of Cottonwood Creek and a 72" culvert at the upper end of the No. 9 Mine Pad. The purpose of the survey was to investigate the existence of tree nesting Raptors along this portion of Cottonwood Creek which will be potentially disturbed in the event the existing culvert is extended.

The area in question comprises a steep stream bank varying from 20' to 26' in length with slopes averaging 1.5 to 1. The area is typical riparian bottom with an overstory of Salix and Populus (sp.) along both banks. The majority of the trees are immature and average in height less than 30' and DBH ranging from 2" to 9". There are two notable exceptions; both larger trees 30+ ' in height and 12" DBH. It was felt that these trees, due to their greater height and more potential nesting habitat (dead limbs, crevices, etc.) offered the most suitable nest structures.

While all the trees were examined for evidence of nests or potential nest sites, the two large trees were examined in more detail. No nest were located.

The area's close proximity to the mine and the abundance of suitable nest sites throughout the general area indicates that no significant sites and or nests will be a risk in the removal of

the trees along the culvert corridor. While a well developed riparian zone will be impacted throughout the life of the mine, it would be unlikely that tree nesting raptors would be impacted.



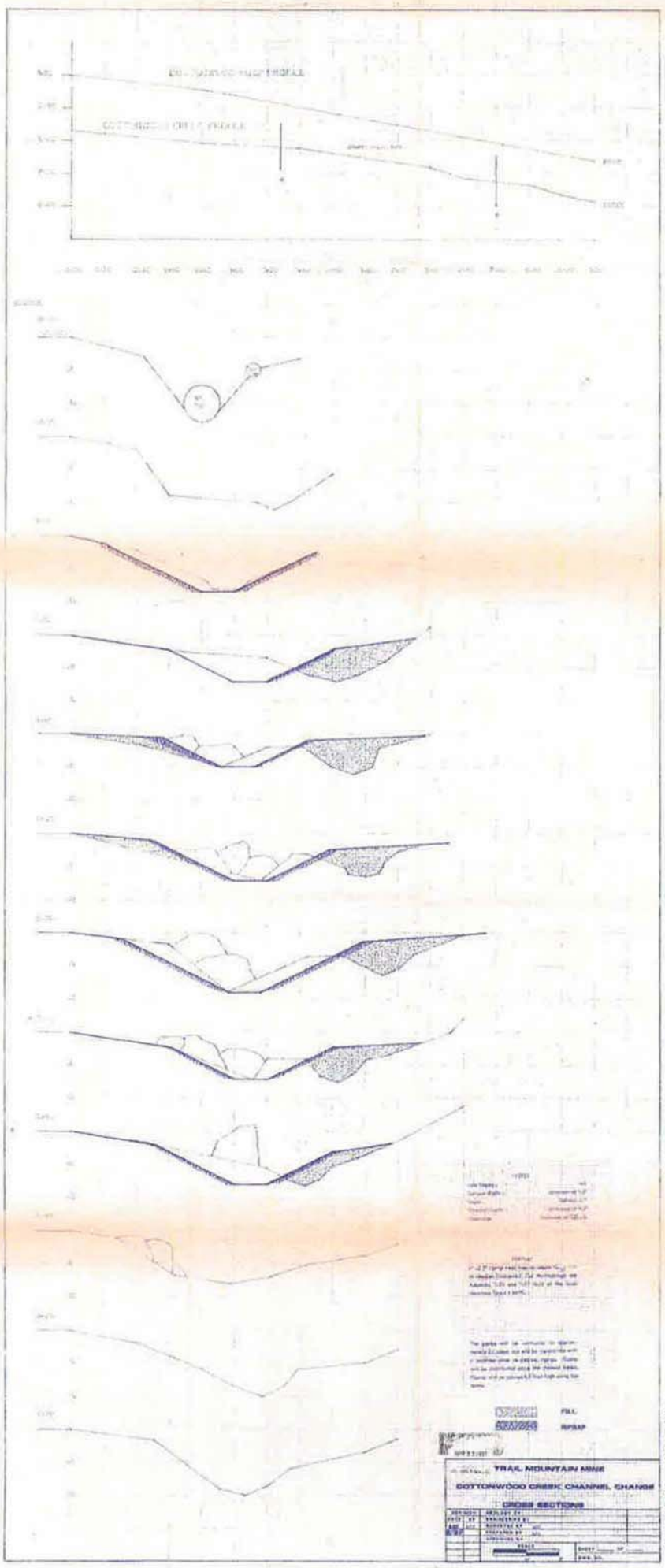

**TOPSOIL STRIPPING MAP**

SECTION D-D'


SECTION C-C'


SECTION B-B'


SECTION A-A'




APPENDIX 7 FIGURE 7-29

APPENDIX 7-14

TRAIL MOUNTAIN TM-3 MONITORING WELL

# APPENDIX 7 - 14

# PROPOSED MONITORING WELL

# SPECIAL CONDITION
# R614-301-731.200

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining

by Hugh Klein date 12-16-92

**PROPOSED MONITORING WELL**

**IN**

**STRAIGHT CANYON**

General

This proposal is to install a ground water monitoring well to monitor quality and quantity of the Star Point aquifer where it leaves the permit area, as required by Special Condition R614-301-731.200. The proposed well will be approximately 500' deep, and will be constructed and monitored in accordance with the requirements of regulations R614-301-713.200 through R614-301-731.215.

Location

The proposed well will be located in Straight Canyon (SW 1/4 NW 1/4 Sec.3,T.18 S., R.6.E) near the area of DH-5 as requested. The location is shown on attached Map 1. A description of Hole UGMS-5 is included in Figure 1.

Location Justification

The proposed location is that which was originally suggested by the Division. This location is still considered the best for the following reasons:

(1) A review of the structure contour map and mining directions (South and West) shows the dip to be very close to due Southwest. The proposed location would be down dip from the mining and is well situated to show potential mining impacts from either the South or West areas;

(2) This location allows for a relatively shallow hole (approximately 500') and still affords accessibility throughout the year. A hole on, or closer to, the actual permit boundary would be on top of the mountain. Such a hole would be extremely deep (1500'-2000') and would be inaccessible during 5 or 6 months out of the year;

(3) The proposed location is one of the very few sites in Straight Canyon where a drilling rig can be placed without extensive regrading or partial blocking of the main road. This site has already been used for drilling access; therefore, environmental impacts would be minimized at this location.



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Approved, Division of Oil, Gas & Mining
by HL date 6-16-92

Drilling Plan

The hole will be drilled using a standard air rotary rig and procedures. As shown on Figure 2, the upper 20' of the hole will be drilled to a 12" diameter to allow placement of a cemented 9 5/8" diameter steel casing and cap. The remainder of the hole will be 8.75" diameter to a point at least 50' into the Star Point Sandstone. A PVC well screen will be installed in the water bearing portion of the aquifer, and a 4"-4.5" PVC well casing/riser pipe will be installed in the remaining upper portion of the hole. The screen will be surrounded with a coarse silica sand gravel pack. The aquifer will be isolated by the use of a bentonite seal, which will be placed in pellet form. The upper, non-aquifer portion of the hole will be filled with a standard gravel pack consisting of drill cuttings or a bentonite grout. Any overlying aquifers will be sealed off above and below with the bentonite seal to prevent contamination of the main aquifer.

The hole will be drilled with air if possible. If water is encountered, and cutting return is lost, water may also be used for drilling. It is not anticipated that other drilling fluids will be required; however, only non-petroleum based fluid would be used in any event. Any recirculation will be within a closed system, using a tank or pit for total containment.

The hole is of sufficient size to allow for a submersible 3 1/2"-4" pump to facilitate sampling for quality and quantity. The steel surface casing will be fitted with a locking well cap for security.

Material

The following is a list of equipment and materials expected to be used in conjunction with this hole:

(1) Standard Air Rotary Drill Rig
(2) compressor
(3) Tank (for recirculation as necessary)
(4) 20' - 9 5/8" diameter steel surface casing
(5) 480' + - 4" - 4.5" PVC well casing
(6) 20' - 50' - PVC well screen
(7) Bentonite Pellets (Seal)
(8) Coarse Silica - Sand/Gravel Pack
(9) Gravel Pack - cuttings or bentonite grout

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Approved, Division of Oil, Gas & Mining
by [illegible] date 6-16-92

Preparation/Reclamation

The preparation will consist of minimal grading to accommodate the drill rig, compressor and recirculation tank. The area has been previously disturbed for drilling and no topsoil appears to be present.

Once drilling is completed, the area will be regraded to provide proper drainage, roughened for retention of seed and moisture and revegetated using the approved seed mix.

When the monitoring well is no longer needed, it will be removed and permanently sealed and reclaimed in accordance with the approved method in the Trail Mountain M.R.P.

Monitoring Plan

The well will be monitored for baseline, operational and post-mining parameters and frequencies as approved in Appendix 7-1 of the Trail Mountain Mining and Reclamation Plan. A copy of the parameter list is included as Attachment 2 of this submittal. Monitoring will be conducted on a quarterly basis, and results will be submitted with the quarterly monitoring reports.

Structure Contour Map

This map shows the structure of the coal seam, mining locations and proposed drill hole (monitoring well) location.

Permit/Approvals

Other required permits or letters of approval for the drilling will be included with this Appendix as they are received.



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by HK date 12-16-92

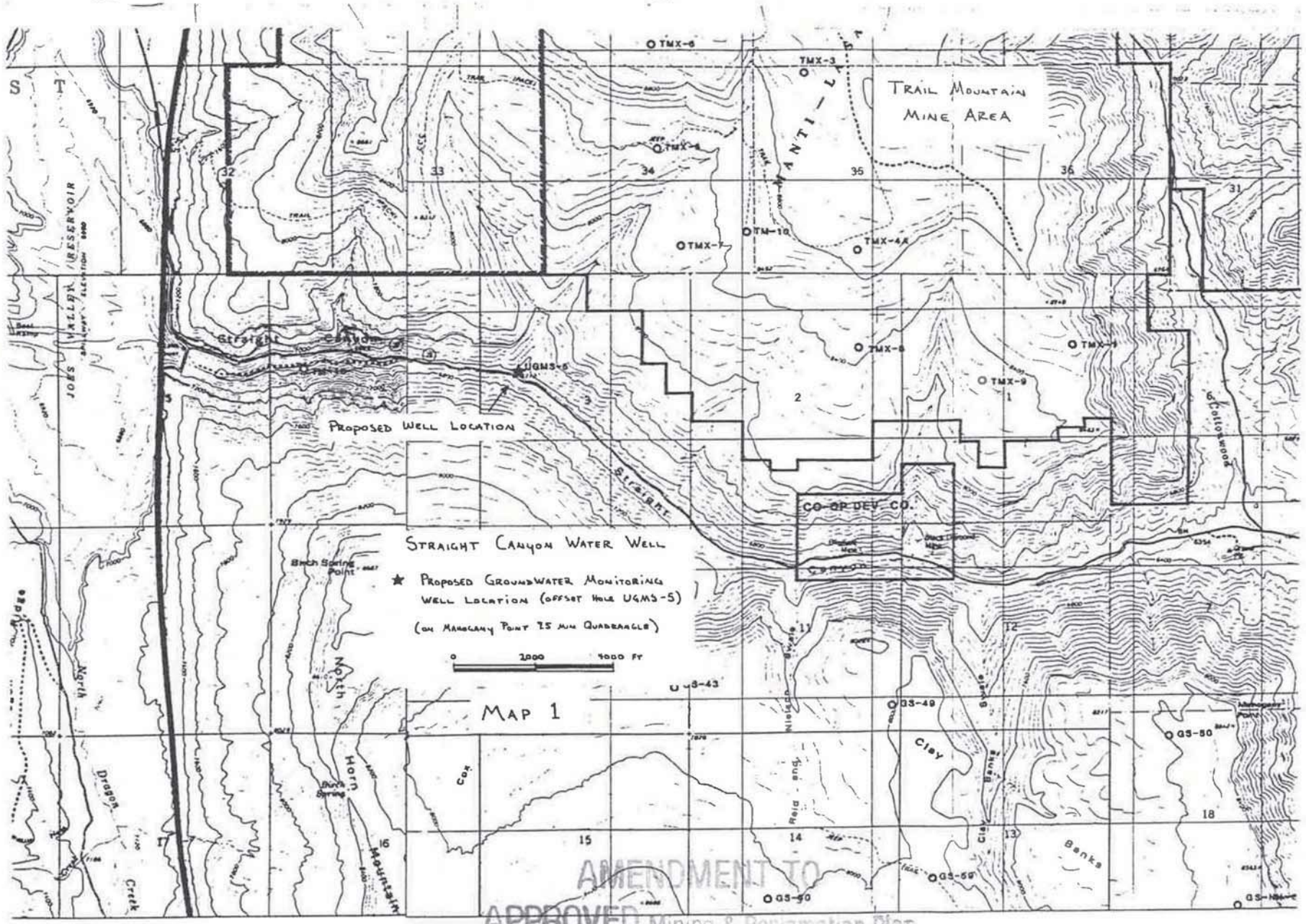


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FIGURE 1

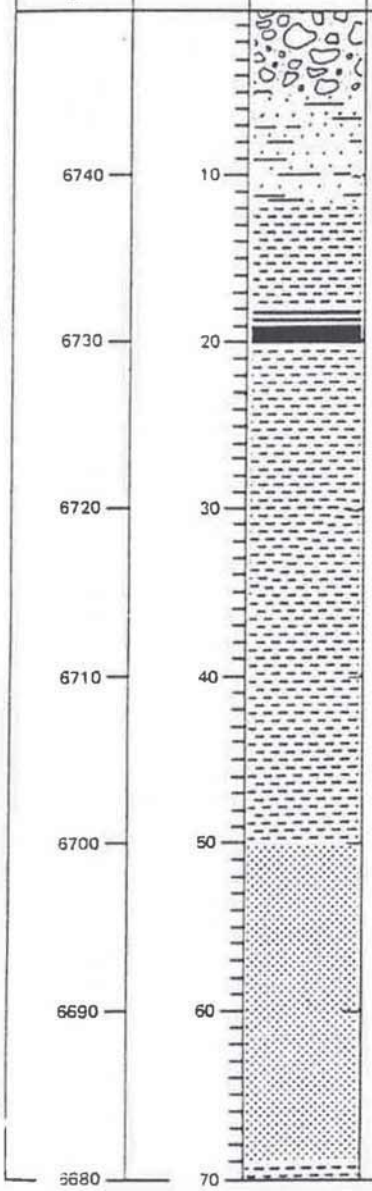


PROJECT Wasatch Plateau Drilling LOCATION SW¼NW¼ sec. 3, T. 18 S., R. 6 E. SHEET 1 OF 6

BEGAN July 7, 1975 COMPLETED July 12, 1975 TOTAL DEPTH OF HOLE 460.0 feet

CORE RECOVERY (%) 100 FEET 200 feet GROUND ELEVATION 6,750 feet

HOLE LOGGED BY H. Doelling, F. Davis, L. Green DRILLER Boyles Brothers DRILL HOLE No. 5




| DESCRIPTION |
|---|
| 0.0 Alluvium |
| 5.0 Sandstone interbedded with shale |
| 12.0 Shale, gray, fissile |
| 18.0 Shale, dark gray, carbonaceous |
| 19.0 Coal, black |
| 20.0 Shale, light gray, fissile |
| 50.5 Sandstone, light gray, fine-grained, calcareous |
| 69.0 Shale, light gray, fissile |

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by HK date 8-11-92

Fig 1 (cont.)



PROJECT Wasatch Plateau Drilling SHEET 2 OF 6

SITE Straight Canyon D.H. No. 5

| ELEVATION | DEPTH | LOG | DESCRIPTION |
|---|---|---|---|
| | | | 71.0 Sandstone, light gray, fine-grained |
| 6670 | 80 | | |
| | | | 83.0 Shale, black, fissile |
| 6660 | 90 | | |
| | | | 92.0 Sandstone, light gray, fine-grained |
| | | | 95.0 Sandstone, gray; interbedded with dark gray shale |
| 6650 | 100 | | |
| | | | 102.0 Shale, black, carbonaceous |
| | | | 107.0 Coal, black |
| | | | 108.5 Shale, dark gray, fissile |
| 6640 | 110 | | |
| | | | 118.0 Sandstone, light gray, fine-grained |
| 6630 | 120 | | |
| | | | 122.0 Shale, dark gray, fissile |
| | | | 126.5 Sandstone, light gray, fine-grained |
| 6620 | 130 | | |
| 6610 | 140 | | |
| | | | 145.0 Shale, black, fissile |
| | | | 146.5 Sandstone, light gray, fine-grained |
| 6600 | 150 | | |

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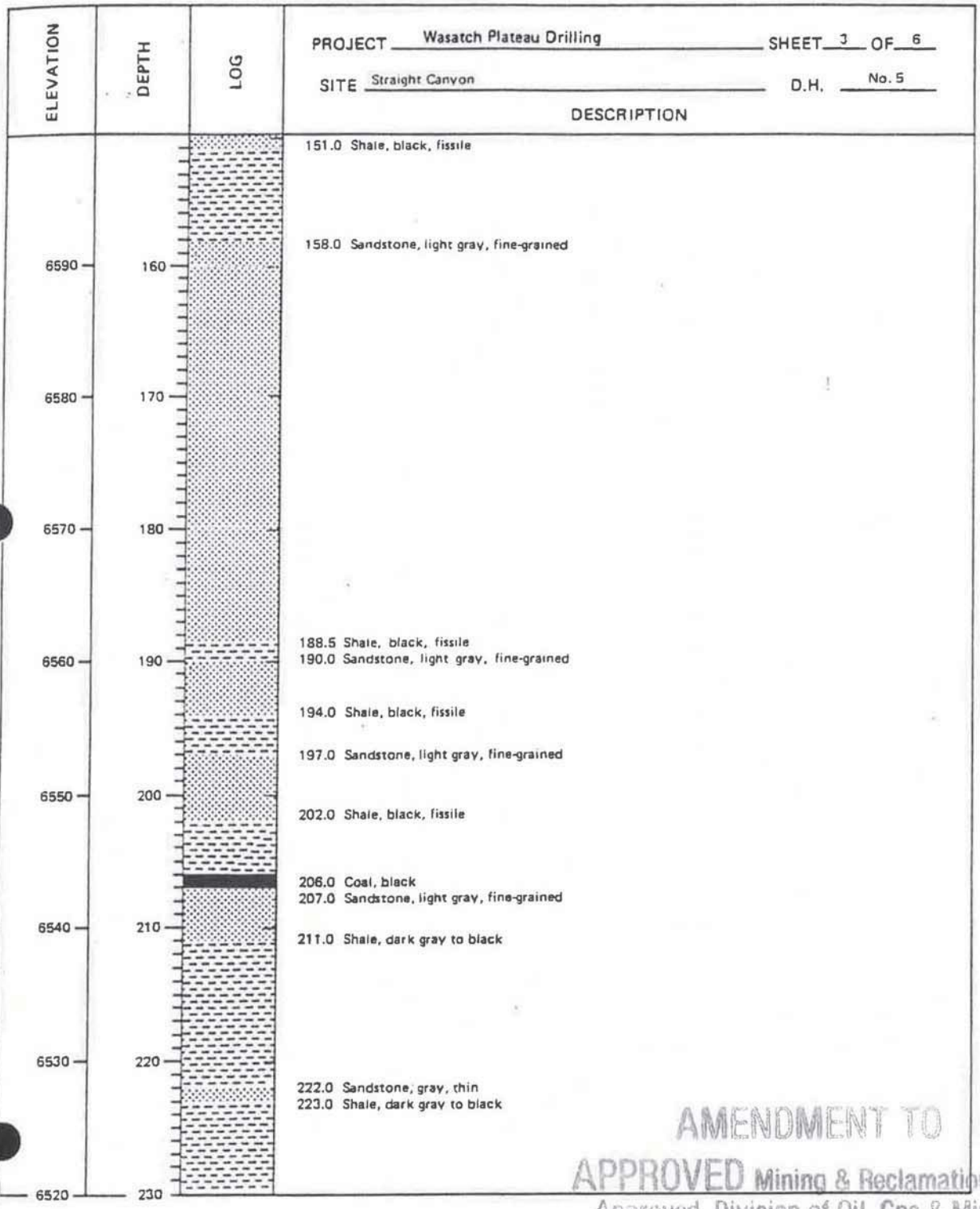
FIG 1 (cont.)



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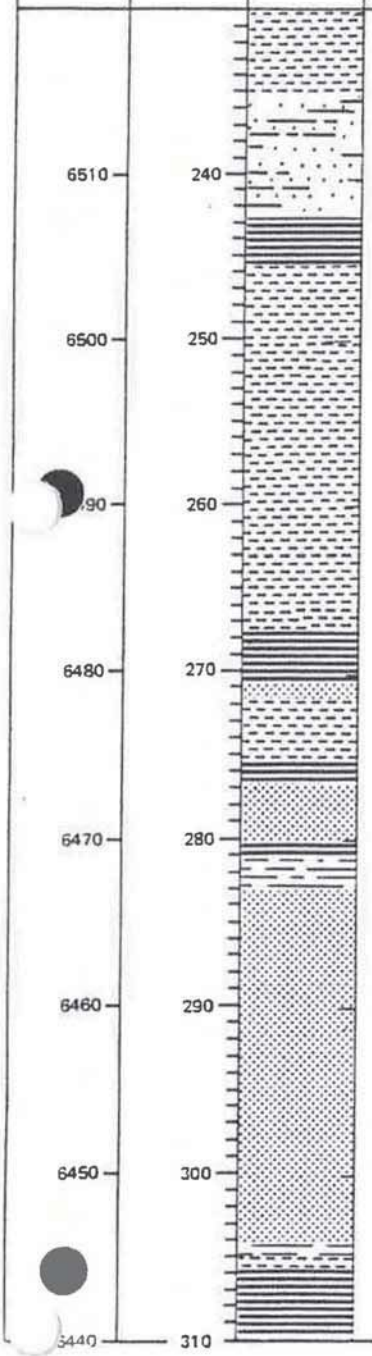
Approved, Division of Oil, Gas & Mining
by HK date 6-16-92

Fig 1 (cont.)



PROJECT Wasatch Plateau Drilling SHEET 4 OF 6

SITE Straight Canyon D.H. No. 5




DESCRIPTION

235.0 Sandstone, gray; interbedded with black shale

242.0 Shale, black, carbonaceous

245.5 Shale, dark gray to black, fissile

Coring began

266.5 Shale, black, carbonaceous; contains leaves and twigs

270.5 Sandstone, medium brown, fine-grained, carbonaceous
271.5 Shale, sandy, medium gray; contains twigs
275.0 Shale, dark gray, carbonaceous
276.5 Sandstone, medium gray, fine-grained, calcareous
280.0 Shale, medium gray, carbonaceous
281.0 Siltstone, medium gray; black streaks
283.0 Sandstone, gray, fine- to medium-grained; occasional thin coaly laminations

304.0 Siltstone
305.0 Shale, dark gray; coaly partings
305.5 Shale, silty, gray, carbonaceous
309.6 Sandstone, light tan, fine-grained

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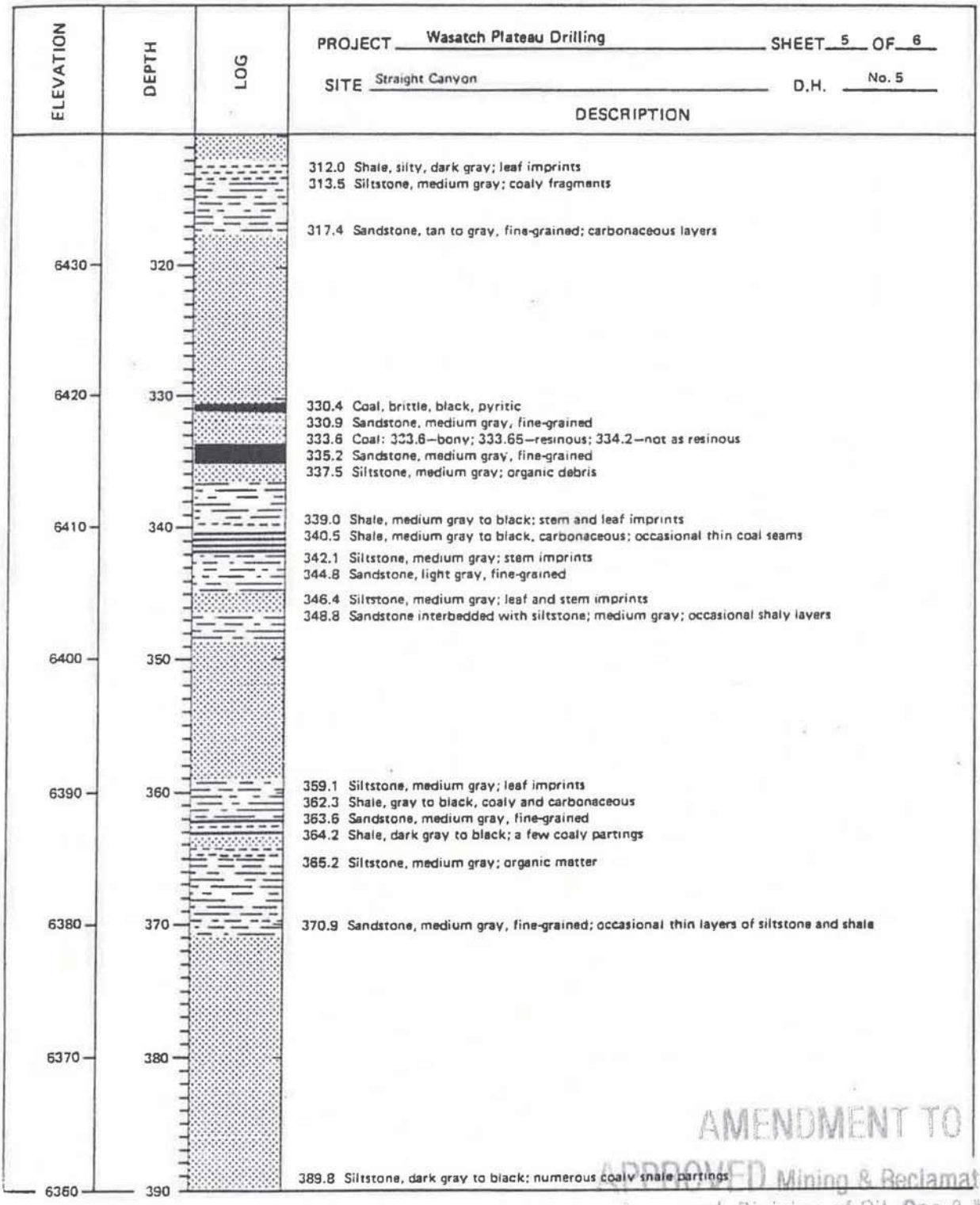
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
By: HC Date: 6-16-92

FIG 1 (cont.)



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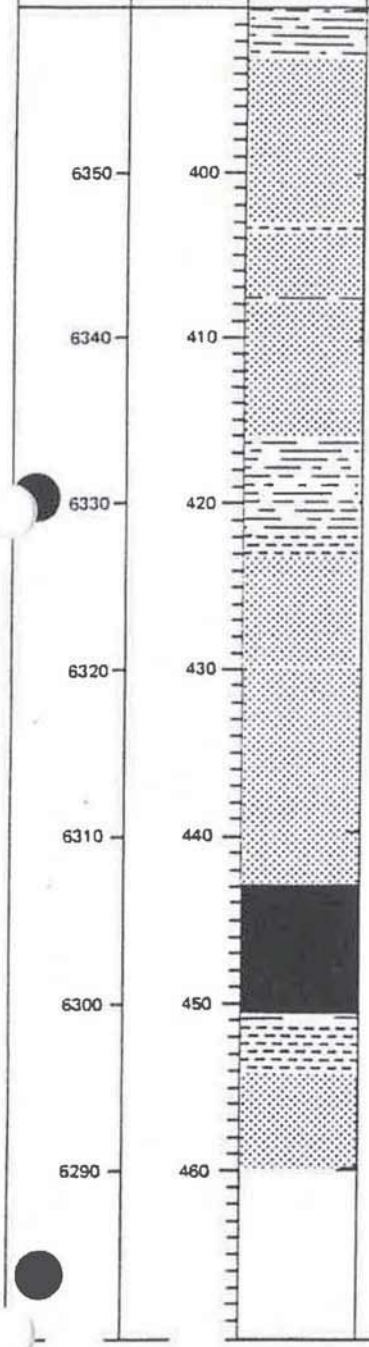
by HK date 6-16-92

FIG 1 (CONT)



PROJECT Wasatch Plateau Drilling SHEET 6 OF 6

SITE Straight Canyon D.H. No. 5




DESCRIPTION

392.6 Sandstone, medium gray, fine-grained

403.1 Shale, sandy, light gray
403.6 Sandstone, light gray, fine-grained

407.6 Siltstone, light gray
408.1 Sandstone, light gray, fine-grained; some coal imprints on bedding planes

416.3 Siltstone, medium gray to black; shaly partings; leaf and stem imprints

421.9 Shale, black; bony coal streaks
423.1 Sandstone, medium gray, fine-grained; leaf and stem imprints

443.6 Coal, hard, black; Hiawatha coal bed

450.9 Coal, bony
451.1 Siltstone, medium gray
452.4 Shale, dark gray; specks of coal
453.9 Sandstone, light gray, medium- to coarse-grained; Star Point Sandstone
460.0 Total depth

AMENDMENT TO
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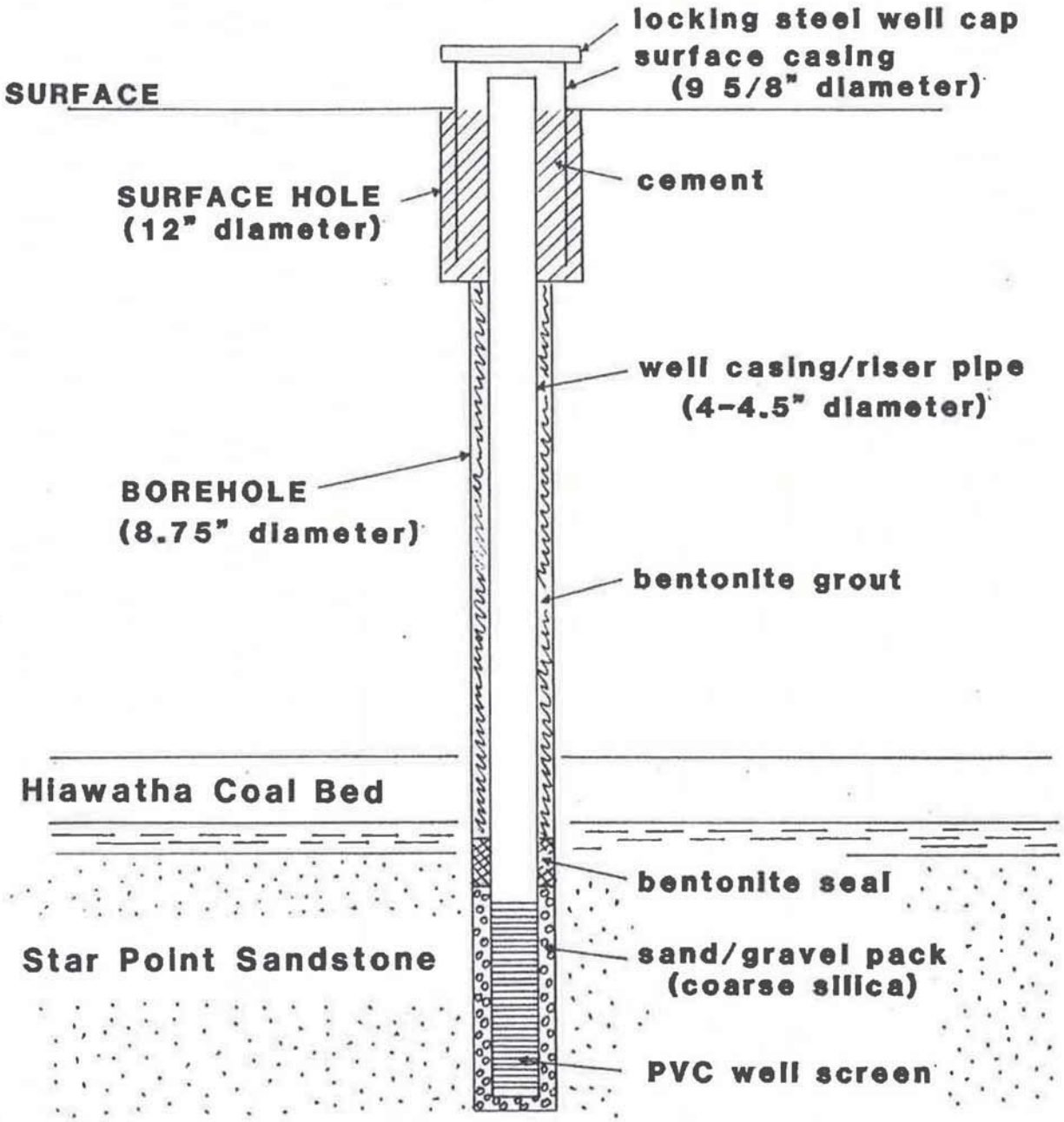
Approved, Division of Oil, Gas & Mining
by HK date 12-16-92

# Straight Canyon Groundwater Monitoring Well




AMENDMENT TO
APPROVED Mining & Reclamation Plan
Received, Division of Oil, Gas & Mining
By HK Date 12-16-92

**Figure 2**

ATTACHMENT 1

PERMITS / APPROVALS

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining

by HK date 6-16-92

STATE OF UTAH
NATURAL RESOURCES
Water Rights

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
Robert L. Morgan, State Engineer

Southeastern Area • 453 S. Carbon Avenue • P O Box 718 • Price, UT 84501-0718 • 801-637-1303

May 15, 1992

Mountain Coal Company
Attn: Mark W. Scanlon, Senior Geologist
P.O. Box 1378
Price, Utah 84501

Re: Monitor Well Application 92-93-01MW
Expiration Date: May 15, 1993

Dear Mr. Scanlon:

Reference is made to your request to drill a monitoring well with reference to the Trail Mountain North Coal Mine in Emery County, Utah. The well will be located in the SW4NW4 Section 3, T18S, R6E, SLB&M.

The information provided in your correspondence dated April 27, 1992 meets the State's requirements for the completion of monitor wells. Permission is hereby granted to complete the well according to your specifications, with the following conditions:

1) This letter grants permission to proceed with the construction of the well. It is understood that a 12-inch bore hole will be constructed to a depth of 20 feet where a 9-5/8 inch surface casing will be set and grouted. The remainder of the bore will be 8-3/4" diameter to a total depth of 500 to 550 feet. A 4-1/2 inch PVC well case will be installed in the bore. Appropriate seals and screening will be installed. Screening will be with slotted PVC pipe. The screened sections will be packed with sand and gravel. The annulus of the bore hole and surface casing will be cemented using Neat Cement. No more water is to be diverted from the wells than is necessary to make them operational and gather the intended data.

2) Following the completion of drilling and testing, the well must be either permanently or temporarily abandoned, as required by Section 12 of the State of Utah Administrative Rules For Well Drillers, adopted July 15, 1987.

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by HC date 6-16-92

3) The drilling contractor must be licensed in the State of Utah, and have a current license as required by the Utah State Engineer. Before starting, he must file with this Division a Notice of Intent to Drill Card. Within thirty days of completion or abandonment of the well, the licensed driller must submit a Driller's Report, as specified under Section 4.3 of the Administrative Rules. Such report is to become part of the file in this Division pertaining to this project.

This is your authorization to have the licensed drilling contractor proceed with your monitor well project. Note that the expiration date of this permit is May 15, 1993. If additional work is still anticipated after this date, a written request for an extension should be forwarded to this office. A statement and associated data from the prior year's activities should accompany the request.

Sincerely,

Mark P. Page

Mark P. Page, Price Regional Engineer
for Robert L. Morgan, P.E., State Engineer

cc: Jerry Bronicel - Division of Water Rights
Hugh Klein - Division of Oil, Gas & Mining

RLM/MPP/mjk

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by HK date 6-16-92

**Mountain Coal Company**
Trail Mountain Mine
Post Office Box 1378
Price, Utah 84501
Telephone 801 637-5050 (Price Office)
801 637-5203 (Mine Office)
801 748-2140 (Mine Site)

*April 27, 1992*

*Mr. Mark Page*
*Utah Division of Water Rights*
*453 S. Carbon Ave.*
*Price, Utah 84501*

*Re:* ***Mountain Coal Company's proposed water monitoring well in Straight Canyon, Emery County, Utah.***

*Dear Mr. Page:*

*As a special condition of the Trail Mtn. No. 9 mining lease permit, Mountain Coal Company is required to construct a ground water well in the Straight Canyon area, to monitor the potential effects of the mine on the local ground water regime.*

*As discussed in our meeting of March 12th, final plan approval by the Utah Division of Oil, Gas, & Mining is contingent upon endorsement from the Division of Water Rights. Enclosed please find a description of the proposed well and our monitoring program for your review. Also enclosed is a completed "Request for Monitoring Well Construction" form.*

*The following items are included within:*

1) *Location map*
2) *Location Justification*
3) *Drilling Plan*
    a) *Materials*
    b) *Methods/Procedures*
    c) *Preparation/Reclamation*
4) *Well Design*
5) *Monitoring Plan*
6) *Structure contour map*
    *(showing location of well and mining)*

*If the necessary approvals can be obtained in a timely manner, this well will be completed in the 1992 drilling season. The selection the drilling contractor has yet to be determined.*

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by HC date 6/16-92

*If you have any questions or need additional information, please contact me at (303) 929-5015 ext. 246.*

*Regards,*

Mark W Scanlon

*Mark W. Scanlon*
*Sr. Geologist*
*Mountain Coal Company*

*cc:* *D. Guy*
*J. Coffey*
*R. Parkins*

mwr

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining

by HK date 6-16-92

DIVISION OF WATER RIGHTS
REQUEST FOR MONITOR WELL CONSTRUCTION

APPLICANTS NAME Mountain Coal Company (Formerly Beaver Creek Coal Company)

APPLICANTS ADDRESS P.O. Box 1378, 1305 S. Carbon Ave., Price, Utah 84501

INDIVIDUAL CONTACT Mr. Dan Guy (Name) (801) 637-7742 (Phone)

CURRENT PROPERTY OWNER United States Government (USFS & BLM Administrators)

PROPOSED NUMBER OF WELLS 1 DIAMETERS 4.5" to T.D. APPROX. DEPTHS 500'- 550'

TYPE OF COMPLETIONS (Casing, intake, gravel pack, grout, etc.) 12" hole w/9 5/8" surface casing cemented; 8 3/4" hole w/4 1/2" PVC well casing/riser pipe to T.D.; coarse silica gravel pack around basel well screen. Remainder of hold grouted with bentonite to isolate aquifer.

PROJECT ENGINEER/MANAGER Mark W. Scanlon, Sr. Geologist (Name) (303) 929-5015 (Phone)
Mountain Coal Company, P.O. Box 591, Somerset, CO 81434 (Address)

GENERAL LOCATION DESCRIPTION Approx. 4 miles up Straight Canyon from Cottonwood. COUNTY Emery

WELLS IN CONJUNCTION WITH (LEAKING) UNDERGROUND STORAGE TANKS ____ Yes X No

NAME OF LICENSED DRILLER Yet to be selected. LICENSE # ----------

PROPOSED CONSTRUCTION DATE 7/92 - 11/92 ANTICIPATED COMPLETION DATE 11/92

LOCATION OF WELLS:

1. N/(S) 1450 FT. &(E)/W 900 FT. FRM NW COR. or SW 1/4 NW 1/4 of SEC. 3 T 18 N/(S) R 6 (E)/W SLBM/USM
2. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM
3. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM
4. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM
5. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM
6. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM
7. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM
8. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM
9. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM
10. N/S_____FT. & E/W_____FT. FRM __COR. or __1/4__1/4 of SEC.___T___N/S R__E/W SLBM/USM

(continued on reverse side)

Comments or explanation Drilled offset of hole UGMS-5; Federal Exploration License may be required.

For office use only

DATE OF REQUEST _____ APP/REJ DATE BY _____
AREA OFFICE _____ AUTHORIZATION # _____

Norman H Bangerter
Governor
Dee C. Hansen
Executive Director
Richard J. Mitchell
Division Director

State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF STATE LANDS AND FORESTRY

355 West North Temple
3 Triad Center, Suite 400
Salt Lake City, Utah 84180-1204
801-538-5508

October 7, 1991

ARCO Coal Company
ATTN: KIM PENOYER
555 Seventeenth Street
Denver, CO 80202

Dear Ms. Penoyer:

RE: Bond No. #U-8003091

This letter is to confirm that on October 7, 1991, the Director of the Division of State Lands and Forestry accepted a $25,000 State of Utah Bond of Lessee, Bond No. 8003091, with Mountain Coal Company as principal and United Pacific Insurance Company as surety, to cover your proposed coal exploration under State Coal leases
ML 23177 and ML 23178.

If you have any questions concerning this matter, please contact this office.

Sincerely,

John T. Blake

JOHN T. BLAKE
MINERAL RESOURCES SPECIALIST

tdw

CC: Mountain Coal Co.
P.O. Box 1378
Price, UT 84501

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
By: HK date 12-16-92

an equal opportunity employer

**ARCO Coal Company**
555 Seventeenth Street
Denver, Colorado 80202
Telephone 303 293 4000

Property Administration

October 1, 1991

Mr. John T. Blake
State of Utah
Department of Natural Resources
355 West North Temple
3 Triad Center, Suite 400
Salt Lake City, UT 84180-1204

Re: Proposed Coal Exploration; ML 23177 and ML 23178
Bond and Letter Agreement
Emery County, Utah

Dear Mr. Blake:

Attached is the requested Bond in the amount of $25,000 and Letter Agreement for the above referenced exploration project.

If you have any questions, I can be reached at (303) 293-4727.

Sincerely,

Kim Penoyer
Lease Administrator

xc: Dan Guy
Alex Papp
Mark Scanlon

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
HL date 6-16-92

# ORIGINAL

BOND NUMBER U-8003091
Corporate Surety Bond

STATE OF UTAH
BOND OF LESSEE

KNOW ALL MEN BY THESE PRESENTS, that we MOUNTAIN COAL COMPANY of PRICE, UTAH Address as principal and UNITED PACIFIC INSURANCE COMPANY, as surety, are held and firmly bound unto the State of Utah in the sum of TWENTY-FIVE THOUSAND Dollars ($ 25,000.00 ) lawful money of the United States to be paid to the Board of State Lands and Forestry, as agent for the State of Utah, for the use and benefit of the State of Utah, and of any patentee or purchaser of any portion of the land covered by the hereinafter described lease heretofore sold or which may hereafter be sold with a reservation to the State of Utah, on the surface or of other mineral deposits of any portion of such lands, for which payment, will and truly to be made, we bind ourselves, and each of us, and each of our heirs, executors, administrators, successors, sub-lessees, and assignees, jointly and severally by these presents.

Signed with our hands and seals this 24TH day of SEPTEMBER in the year of our Lord, 1991.

The condition of the foregoing obgliation is such that,

WHEREAS, The State of Utah, as Lessor, issued a(n) COAL lease, Lease Numbers ML23177 and ML23178 and dated JANUARY 10, 1966, to ZIONS FIRST NATIONAL BANK TRUSTEE FOR THE MCKINNON ESTATE as lessee (and said lease has been duly assigned under date of _____ to _____) to drill for, mine, extract, and remove all of the COAL deposits in and under the following described lands to wit:

NOW, THEREFORE, THE principal shall be obligated to pay all monies, rentals, royalties, cost of reclamation, damages to the surface and improvements thereon and any other costs which arise by operation of the above described lease(s) accruing to the Lessor and shall fully comply with all other terms and conditions of said lease, the rules, regulations, and policies relating thereto of the Board of State Lands and Forestry, Division of State Lands and Forestry, the Board of Oil, Gas and Mining, and the Division of Oil, Gas and Mining as they may now exist or may from time to time be modified or amended. This obligation is in effect even if the principal has conveyed part of the purchase agreement interest to a successor in interest. If the principal fully satisfies the above described obligations, then the surety's obligation to make payment to the State of Utah is void and of no effect, otherwise, it shall remain in full force and effect until released by the Division of State Lands and Forestry.

Signed, sealed and delivered in the presence of

E. L. Marguardsen
Witness

Vivienne Douglas
Witness

MOUNTAIN COAL COMPANY

Thomas H Parker (SEAL)
Principal

BONDING COMPANY UNITED PACIFIC INSURANCE COMPANY
BY _____
CASSIE J. BERRISFORD, ATTORNEY-IN-FACT

Attest: SEE ATTACHED POWER OF ATTORNEY

Resident Agent: N/A

Bonding Co. Address: 505 NORTH BRAND BLVD., SUITE 770, GLENDALE, CALIFORNIA 91203

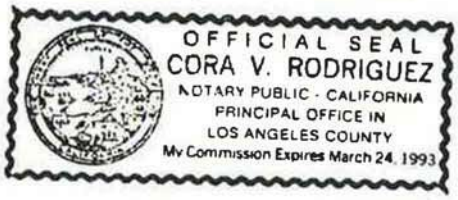
Corporate Seal of Bonding Company Must be Affixed.

APPROVED AS TO FORM:
R. PAUL VAN DAM
ATTORNEY GENERAL
By David K Christensen

**CALIFORNIA**
**ACKNOWLEDGEMENT BY SURETY**

STATE OF CALIFORNIA
COUNTY OF LOS ANGELES } ss.

On this 24TH day of SEPTEMBER in the year 19 91, before me CORA V. RODRIGUEZ personally appeared CASSIE J. BERRISFORD, personally known to me (or proved to me on the basis of satisfactory evidence) to be the person who executed the within instrument as attorney-in-fact of UNITED PACIFIC INSURANCE COMPANY and acknowledged to me that the corporation executed it.




Cora V. Rodriguez
Notary Public

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by HR date 6-11-92

# UNITED PACIFIC INSURANCE COMPANY

**HEAD OFFICE, FEDERAL WAY, WASHINGTON**

## POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS, That the UNITED PACIFIC INSURANCE COMPANY, a corporation duly organized under the laws of the State of Washington, does hereby make, constitute and appoint

CASSIE J. BERRISFORD of LOS ANGELES, CALIFORNIA

its true and lawful Attorney-in-Fact, to make, execute, seal and deliver for and on its behalf, and as its act and deed

ANY AND ALL BONDS AND UNDERTAKINGS OF SURETYSHIP ----

and to bind the UNITED PACIFIC INSURANCE COMPANY thereby as fully and to the same extent as if such bonds and undertakings and other writings obligatory in the nature thereof were signed by an Executive Officer of the UNITED PACIFIC INSURANCE COMPANY and sealed and attested by one other of such officers, and hereby ratifies and confirms all that its said Attorney(s)-in-Fact may do in pursuance hereof.

This Power of Attorney is granted under and by authority of Article VII of the By-Laws of UNITED PACIFIC INSURANCE COMPANY which became effective September 7, 1978, which provisions are now in full force and effect, reading as follows:

### ARTICLE VII — EXECUTION OF BONDS AND UNDERTAKINGS

1. The Board of Directors, the President, the Chairman of the Board, any Senior Vice President, any Vice President or Assistant Vice President or other officer designated by the Board of Directors shall have power and authority to (a) appoint Attorneys-in-Fact and to authorize them to execute on behalf of the Company, bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof, and (b) to remove any such Attorney-in-Fact at any time and revoke the power and authority given to him.

2. Attorneys-in-Fact shall have power and authority, subject to the terms and limitations of the power of attorney issued to them, to execute and deliver on behalf of the Company, bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof. The corporate seal is not necessary for the validity of any bonds and undertakings, recognizances, contracts of indemnity and other writings obligatory in the nature thereof.

3. Attorneys-in-Fact shall have power and authority to execute affidavits required to be attached to bonds, recognizances, contracts of indemnity or other conditional or obligatory undertakings and they shall also have power and authority to certify the financial statement of the Company and to copies of the By-Laws of the Company or any article or section thereof.

This power of attorney is signed and sealed by facsimile under and by authority of the following Resolution adopted by the Board of Directors of UNITED PACIFIC INSURANCE COMPANY at a meeting held on the 5th day of June, 1979, at which a quorum was present, and said Resolution has not been amended or repealed:

> "Resolved, that the signatures of such directors and officers and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signatures or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by facsimile signatures and facsimile seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached."

IN WITNESS WHEREOF, the UNITED PACIFIC INSURANCE COMPANY has caused these presents to be signed by its Vice President, and its corporate seal to be hereto affixed, this 7th day of May 19 90

UNITED PACIFIC INSURANCE COMPANY

SEAL 1979

Vice President

STATE OF Washington
COUNTY OF King } ss.

On this 7th day of May, 19 90 personally appeared Lawrence W. Carlstrom

to me known to be the Vice-President of the UNITED PACIFIC INSURANCE COMPANY, and acknowledged that he executed and attested the foregoing instrument and affixed the seal of said corporation thereto, and that Article VII, Section 1, 2, and 3 of the By-Laws of said Company and the Resolution, set forth therein, are still in full force.

My Commission Expires:
May 15 .19 90

NOTARY PUBLIC STATE OF WASHINGTON

Pamela Young

Notary Public in and for State of Washington

Residing at Tacoma

I, Robert D. Ritzhaupt, Assistant Secretary of the UNITED PACIFIC INSURANCE COMPANY, do hereby certify that the above and foregoing is a true and correct copy of a Power of Attorney executed by said UNITED PACIFIC INSURANCE COMPANY, which is still in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said Company this 24TH day of SEPTEMBER 19 91

SEAL 1979

Assistant Secretary Robert D. Ritzhaupt

Robert D. Ritzhaupt

SDU-1431 Ed. 4/80

ATTACHMENT 2

WATER MONITORING PARAMETERS

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
HK date 6-16-92

GROUND WATER BASELINE, OPERATIONAL AND
POSTMINING WATER QUALITY PARAMETER LIST

Field Measurements:

* - Water Levels or Flow
* - pH
* - Specific Conductivity (umhos/cm)
* - Temperature ($C^o$)

Laboratory Measurements: (mg/l) (Major, minor ions and trace elements are to be analyzed in dissolved form only.)

* - Total Dissolved Solids
* - Total Hardness (as $CaCO_3$)
- Aluminum (Al)
- Arsenic (As)
- Barium (Ba)
- Boron (B)
* - Carbonate ($CO_3^{-2}$)
* - Bicarbonate ($HCO_3^-$)
- Cadmium (Cd)
* - Calcium (Ca)
* - Chloride ($CL^-$)
- Chromium (Cr)
- Copper (Cu)
- Fluoride ($F^-$)
* - Iron (Fe)
- Lead (Pb)
* - Magnesium (Mg)
* - Manganese (Mn)
- Mercury (Hg)
- Molybdenum (Mo)
- Nickel (Ni)
- Nitrogen: Ammonia ($NH_3$)
- Nitrite ($NO_2$)
- Nitrate ($NO_3^-$)
* - Potassium (K)
- Phosphate ($PO_4^{-3}$)
- Selenium (Se)
* - Sodium (Na)
* - Sulfate ($SO_4^{-2}$)
- Sulfide ($S^=$)
- Zinc (Zn)

---

Sampling Period:

-Baseline
*Operational, Postmining

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining
by HHC date 12-16-92

# TRAIL MOUNTAIN
# AQUIFER TEST RESULTS

## SLUG TEST METHODS

Recovery Test Methods

The hydraulic conductivity (permeability) and transmissivity were determined by conducting a recovery test in the Straight Canyon well - TM-3. Recovery/slug tests are considered to provide adequate information about hydraulic conditions in areas in which studies are not aimed at designing an aquifer exploitation program (Freeeze and Cherry, 1979). In the case of TM-3 (under artisan pressure) located in Straight Canyon, a time recovery method was utilized to obtain the data. A pressure gauge was installed on the well head prior to the aquifer test. The test procedure included: 1) recording the initial well head pressure, 2) allowing the well flow to flow for a period of approximately three hours, 3) recording the flow to document well output variations, 4) shutting-in the well and monitoring recovery pressure with the pressure gauge for a period of two hours on a logarithmic frequency.

The data set collected from the recovery test was stored as a comma-delineated ASCII data file. The contents of the data file were subsequently transferred to computer software (AQTESOLV™, Duffield and Rumbaugh, 1989) designed to aid in the analysis of hydraulic test data. The AQTESOLV™ software greatly reduces analysis time when evaluating recovery/slug test data.

Several analytical methods are available in the AQTESOLV™ software for the evaluation of the slug test/recovery data obtained from wells penetrating unconfined or confined aquifers. The analytical method used to estimate the hydraulic conductivity and transmissivity of the screened interval in TM-3 is listed below:

| Well ID. | Geologic Formation | Aquifer Type | Method |
|---|---|---|---|
| TM-3 | Starpoint Sandstone | Confined | Theis Recovery |

The Theis (1935) equation for unsteady flow to a well in a confined aquifer was utilized to compute the transmissivity for well TM-3. The method developed by Theis (1935) uses a curve matching procedure to determine the transmissivity of unconfined aquifers from recovery test data. Hydraulic conductivity can then be determined by dividing the transmissivity by the aquifer thickness. AQTESOLV™ plots the ratio of the measured head, H, to the head after injection of the slug, $H_0$, as a function of time, t. The $H/H_0$ ratio is plotted on the arithmetic scale, and t is plotted on the logarithmic scale of a semilogarithmic graph. AQTESOLV™ then compares the plot of the field data with a series of theoretical type curves, keeping the arithmetic axes coincident. The vertical time axis of the field-data plot which overlies the vertical axis for $Tt/r_c^2 = 1.0$ from the matched type curve is selected.

The transmissivity, T, for the recovery test data from well TM-3 is then derived from the equation:

$$\textit{Theis} \qquad s'' = Q / ( 4\pi T ) \left( \ln \frac{4Tt}{r^2 S} - \ln \frac{4Tt''}{r^2 S''} \right)$$

where:

- s" = residual drawdown (L)
- S = coefficient of storage during pumping
- S"= coefficient of storage during recovery
- t" = time since pumping stopped (T)

The Theis method reports storage coefficient in the output file. However, according to Freeze and Cherry (1979, p. 342), determining the storage coefficient from slug test data does not yield reliable results. Therefore, the values of storage coefficient noted on the graphical printouts for the confined-aquifer slug tests should be disregarded.

**RECOVERY TEST RESULTS**
**(see attachments)**

| WELL NO. | AQUIFER TYPE | PERMEABILITY (ft/min) | TRANSMISSIVITY ($ft^2$/min) |
|---|---|---|---|
| TM - 3 | Confined | 2.60E-4 | 2.46E-2 |

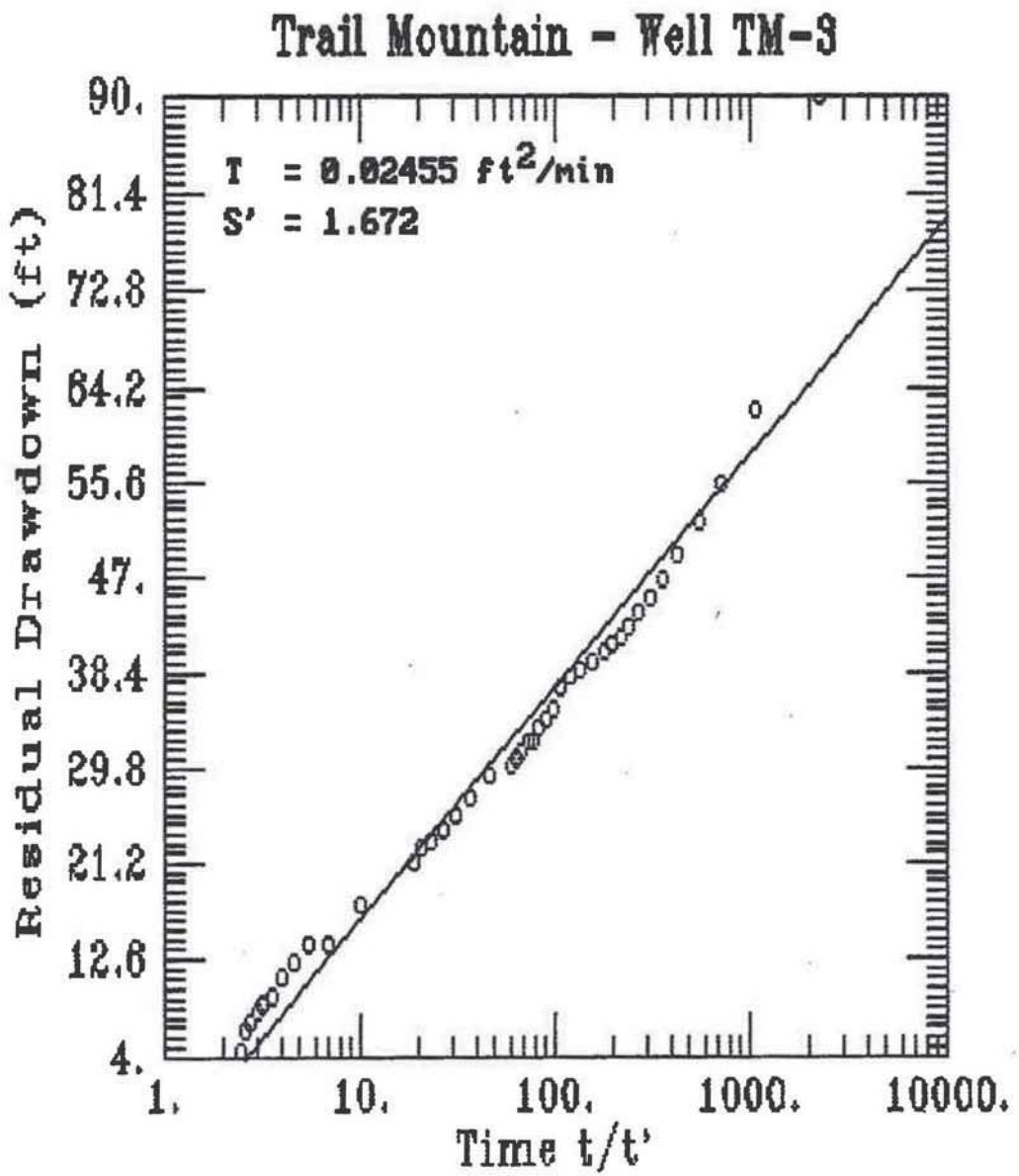
## REFERENCES


Duffield, G.M. and J.O. Rumbaugh, III. 1989. AQTESOLV™: Aquifer Test Design and Analysis Computer Software. Geraghty and Miller, Inc Environmental Services Modeling Group. Reston, Virginia.

Freeeze, R.A. and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate duration of discharge of a well using groundwater storage, Am Geophys. Union Trans., Vol. 16, pp. 519-524.

# TRAIL MOUNTAIN
# RECOVERY TEST RESULTS
# MAY 1994


Trail Mountain - Well TM-3
T = 0.02455 ft²/min
S' = 1.672
Residual Drawdown (ft)
90.
81.4
72.8
64.2
55.6
47.
38.4
29.8
21.2
12.6
4.
1.
10.
100.
1000.
10000.
Time t/t'

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

# A Q T E S O L V   R E S U L T S
Version 1.10

05/26/94 10:04:41

---

## TEST DESCRIPTION

Data set........... tm-3.in
Data set title..... Trail Mountain - Well TM-3

Knowns and Constants:
No. of data points.................. 42
Pumping rate........................ 2.81
Total pumping time.................. 180

---

## ANALYTICAL METHOD

Theis Recovery (Confined Aquifer)

---

## RESULTS FROM STATISTICAL CURVE MATCHING

STATISTICAL MATCH PARAMETER ESTIMATES

| | Estimate | | Std. Error |
|---|---|---|---|
| T = | 2.4554E-002 | +/- | 1.0151E-003 |
| S' = | 1.6718E+000 | +/- | 2.6615E-001 |

ANALYSIS OF MODEL RESIDUALS

residual = calculated - observed
weighted residual = residual * weight

Weighted Residual Statistics:
Number of residuals............... 42
Number of estimated parameters.... 2
Degrees of freedom................ 40
Residual mean..................... -3.517E-010
Residual standard deviation....... 4.404
Residual variance................. 19.39

Model Residuals:

| Time | Observed | Calculated | Residual | Weight |
|---|---|---|---|---|
| 0.08 | 90 | 65.63 | 24.37 | 1 |
| 0.17 | 62.31 | 58.769 | 3.5409 | 1 |
| 0.25 | 55.38 | 55.26 | 0.11973 | 1 |
| 0.33 | 51.92 | 52.735 | -0.81545 | 1 |

TM-3

| | | | | |
|---|---|---|---|---|
| 0.42 | 49.04 | 50.543 | -1.5033 | 1 |
| 0.5 | 46.73 | 48.959 | -2.2292 | 1 |
| 0.58 | 45 | 47.611 | -2.6114 | 1 |
| 0.67 | 43.85 | 46.302 | -2.452 | 1 |
| 0.75 | 42.69 | 45.279 | -2.5886 | 1 |
| 0.83 | 41.54 | 44.359 | -2.8194 | 1 |
| 0.92 | 40.96 | 43.426 | -2.4662 | 1 |
| 1 | 40.38 | 42.671 | -2.2908 | 1 |
| 1.17 | 39.23 | 41.249 | -2.0192 | 1 |
| 1.33 | 38.65 | 40.09 | -1.4398 | 1 |
| 1.5 | 38.08 | 39.003 | -0.92264 | 1 |
| 1.67 | 36.92 | 38.033 | -1.1133 | 1 |
| 1.83 | 35.19 | 37.208 | -2.0179 | 1 |
| 2 | 34.04 | 36.407 | -2.3673 | 1 |
| 2.17 | 33.46 | 35.673 | -2.2127 | 1 |
| 2.33 | 32.31 | 35.033 | -2.7227 | 1 |
| 2.5 | 32.31 | 34.4 | -2.0897 | 1 |
| 2.67 | 31.15 | 33.809 | -2.659 | 1 |
| 2.83 | 30.58 | 33.287 | -2.7068 | 1 |
| 3 | 30 | 32.764 | -2.7639 | 1 |
| 4 | 28.85 | 30.193 | -1.3432 | 1 |
| 5 | 27.12 | 28.21 | -1.09 | 1 |
| 6 | 25.38 | 26.598 | -1.2184 | 1 |
| 7 | 24.23 | 25.243 | -1.0131 | 1 |
| 8 | 23.08 | 24.075 | -0.99541 | 1 |
| 9 | 22.5 | 23.051 | -0.55088 | 1 |
| 10 | 21.35 | 22.139 | -0.78925 | 1 |
| 20 | 17.31 | 16.293 | 1.0172 | 1 |
| 30 | 13.85 | 13.044 | 0.80603 | 1 |
| 40 | 13.85 | 10.847 | 3.0027 | 1 |
| 50 | 12.12 | 9.2196 | 2.9004 | 1 |
| 60 | 10.96 | 7.9466 | 3.0134 | 1 |
| 70 | 9.23 | 6.9143 | 2.3157 | 1 |
| 80 | 8.65 | 6.0553 | 2.5947 | 1 |
| 90 | 8.08 | 5.3262 | 2.7538 | 1 |
| 100 | 6.92 | 4.6978 | 2.2222 | 1 |
| 110 | 6.35 | 4.1492 | 2.2008 | 1 |
| 120 | 4.62 | 3.6655 | 0.95452 | 1 |

**PROCESS INSTRUMENTS & CONTROLS**

479 West 4380 South
Salt Lake City, Utah 84123
(801) 262-5568
Telefax: (801) 262-5806

*VALVES • FITTINGS • INSTRUMENTATION • ACTUATORS • CONTROLS • SWITCHES*

4/28/94

TM-3
START FLOW @ 1010 START 63 PSIG
STOP @ 1310

| SECONDS | |
|---|---|
| 0 | 0 |
| 5 | 14.00 |
| 10 | 36.00 |
| 15 | 39.00 |
| 20 | 40.50 |
| 25 | 41.75 |
| 30 | 42.75 |
| 35 | 43.50 |
| 40 | 44.00 |
| 45 | 44.50 |
| 50 | 45.00 |
| 55 | 45.25 |
| 1 MIN 60 | 45.50 |
| 70 | 46.00 |
| 80 | 46.25 |
| 90 | 46.50 |
| 100 | 47.00 |
| 110 | 47.75 |
| 120 | 48.25 |
| 130 | 48.50 |
| 140 | 49.00 |
| 150 | 49.00 |
| 160 | 49.50 |
| 170 | 49.75 |
| MIN 180 | 50.00 |
| 4 | 50.50 |
| 5 | 51.25 |
| 6 | 52.00 |
| 7 | 52.50 |
| | 53.00 |
| | 53.25 |
| | 53.75 |

| MINUTES | |
|---|---|
| 20 | 55.5 |
| 30 | 57.00 |
| 40 | 57.00 |
| 50 | 57.75 |
| 60 | 58.25 |
| 70 | 59.00 |
| 80 | 59.25 |
| 90 | 59.50 |
| 100 | 60.00 |
| 110 | 60.25 |
| 120 | 61.00 |

FLOW (START FLOW @ 1010

| TIME | FLOW (SEC/5 GAL) | GPM |
|---|---|---|
| 1012 | 14.3 | 21.0 |
| 1022 | 13.9 | 21.6 |
| 1032 | 14.3 | 21.0 |
| 1042 | 14.4 | 20.8 |
| 1052 | 14.2 | 21.1 |
| 1102 | 14.3 | 21.0 |
| 1112 | 14.2 | 21.1 |
| 1122 | 14.3 | 21.0 |
| 1132 | 14.1 | 21.3 |
| 1142 | 14.5 | 20.7 |
| 1152 | 14.4 | 20.8 |
| 1202 | 14.2 | 21.1 |
| 1212 | 14.6 | 20.5 |
| 1242 | 14.4 | 20.8 |
| | | $\bar{X}$ = 21.0 |

# PACIFICORP ELECTRIC OPERATIONS
## FUEL RESOURCES
## COAL LITHOLOGIC LOG

PROJECT: Trail Mountain
DRILL HOLE: TM-3 (UGMS-5)
PAGE 1 of 1

LOCATION: Straight Canyon, Sec. 3
COLLAR ELEV.: 6750 EST
HOLE TYPE: PLUG
PLUG INTERVAL: 0 - 560'
CORE INTERVAL: -
TOTAL DEPTH: 560'
DATE: Sept. 28, 1993
SCALE:
GEOLOGIST: Semborski

| GEOPHYSICAL DATA | | |
|---|---|---|
| LOG | FROM | TO |
| DENSITY: | 300 | 540 |
| H.R.D.: | 400 | 540 |
| E. LOG: | — | |
| GAMMA: | 0 | 540 |
| CALIPER: | — | |
| S.P.: | — | |

| COAL SUMMARY: | | |
|---|---|---|
| SEAM | THICK | INT. |
| Hiawatha | 7.6' | |
| (Top | 447.2 | |
| Base | 454.8) | |

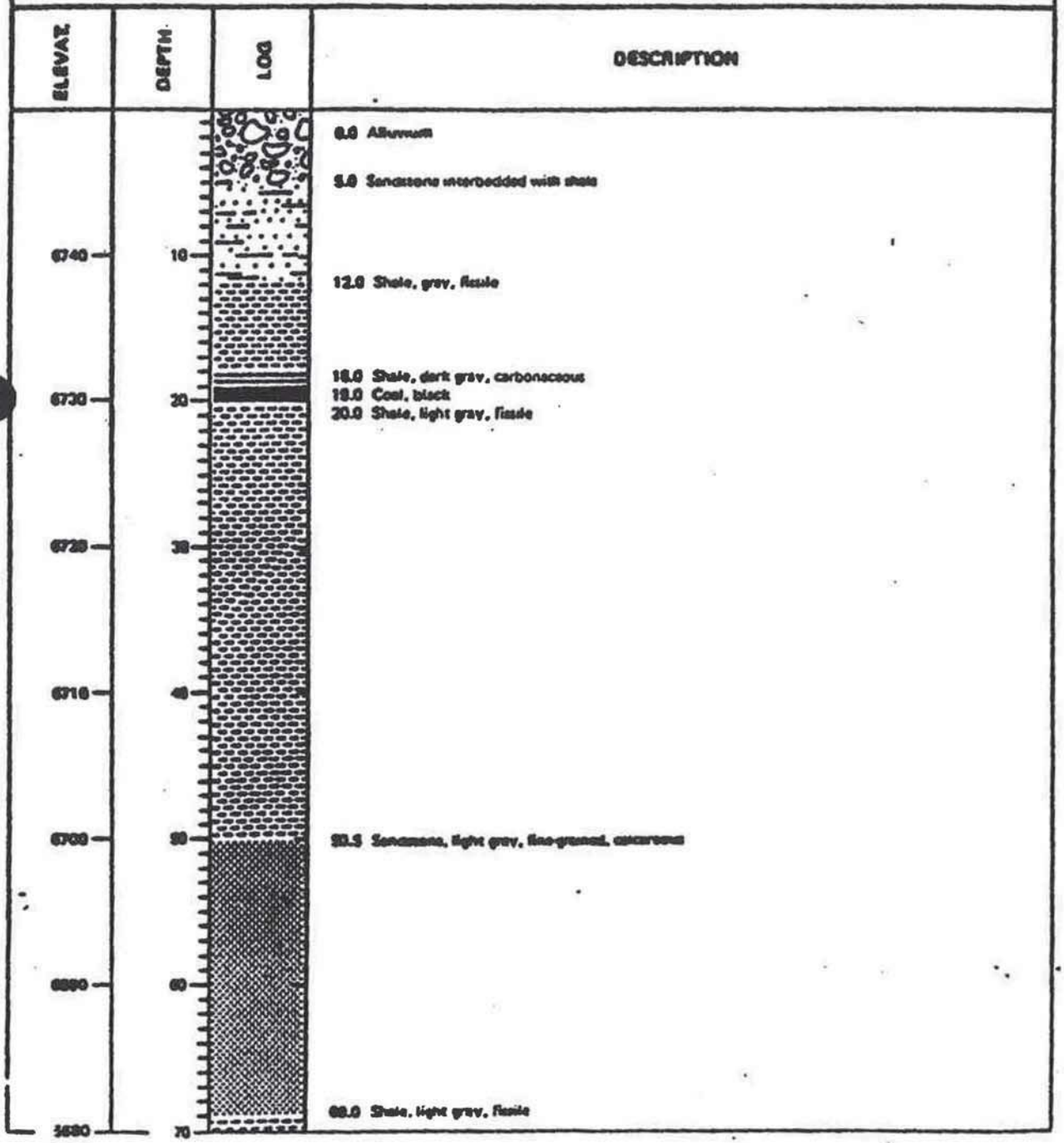
| DEPTH | PLUG | CORE | GRAPHIC LOG | FORMATION NAME | LITHOLOGIC DESCRIPTION | R.Q.D. | BOX # | RUN # | % REC. | SAMPLE |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | BLACKHAWK FORMATION | WATER MONITORING - EXTENSION OF UGMS-5 LITHOLOGY FROM 0-460 REVIEW ATTACHED LOG (UGMS-5) | | | | | |
| 460 | | | | STARPOINT SANDSTONE FORMATION | 460.0' - 491.0' SANDSTONE, LIGHT GRAY, FINE TO MEDIUM GRAIN | | | | | |
| 480 | | | | | | | | | | |
| | | | | | 491.0' - 502.0' SANDSTONE, LIGHT GRAY FINE GRAIN, SHALE LAMINA | | | | | |
| 500 | | | | | 502.0' - 531.0' SANDSTONE LIGHT GRAY FINE - MEDIUM GRAIN | | | | | |
| 520 | | | | | | | | | | |
| | | | | | 531.0' - 555' SANDSTONE, LIGHT GRAY, VFG, SHALE LAMINA | | | | | |
| 540 | | | | | | | | | | |
| | | | | | 555' - 560' MUDSTONE/SILTSTONE INTERBEDS | | | | | |
| 560 | | | | | T. D. 560' | | | | | |

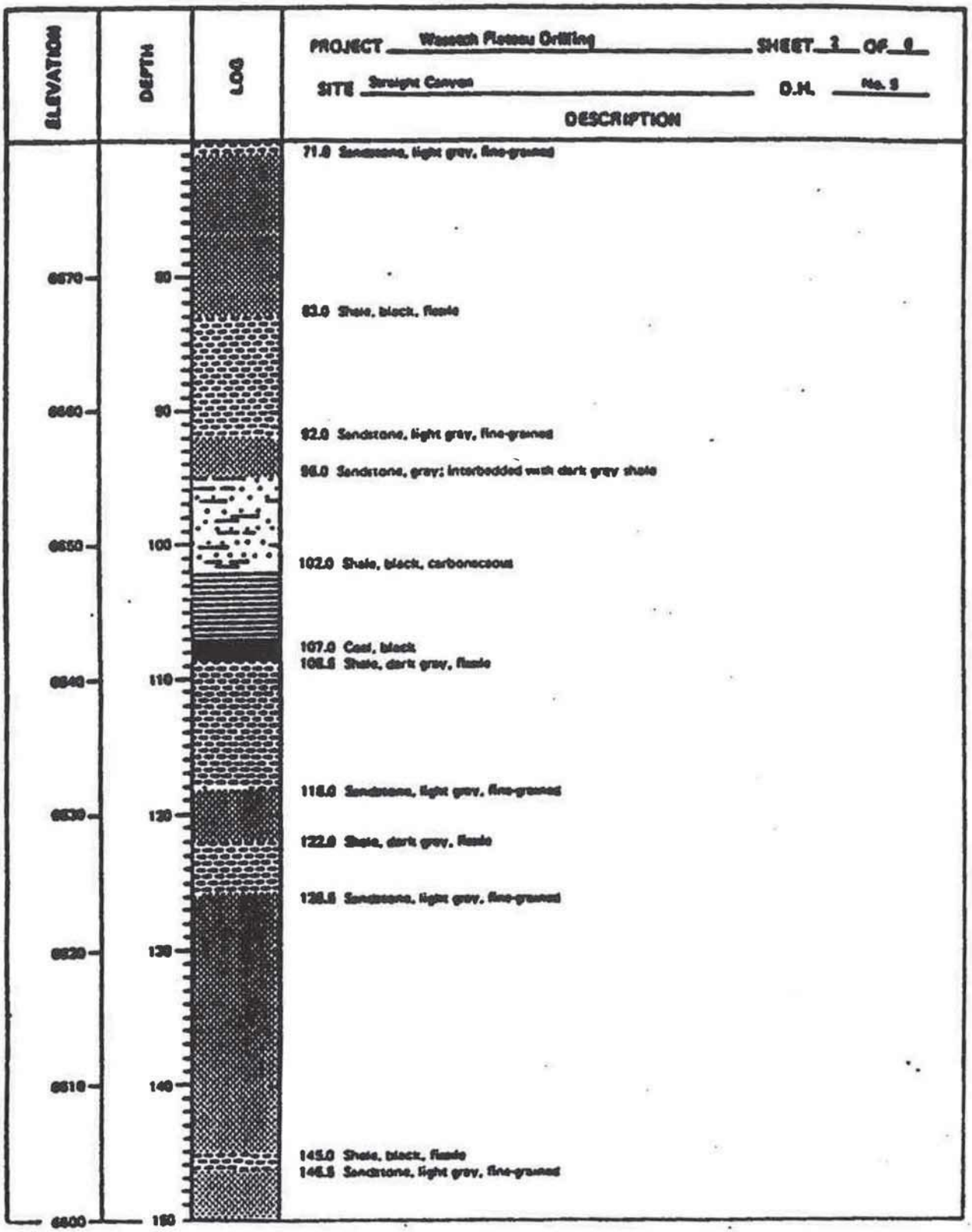
PROJECT Wasatch Plateau Drilling LOCATION SW¼NW¼ sec. 3, T. 19 S., R. 6 E. SHEET 1 OF 6

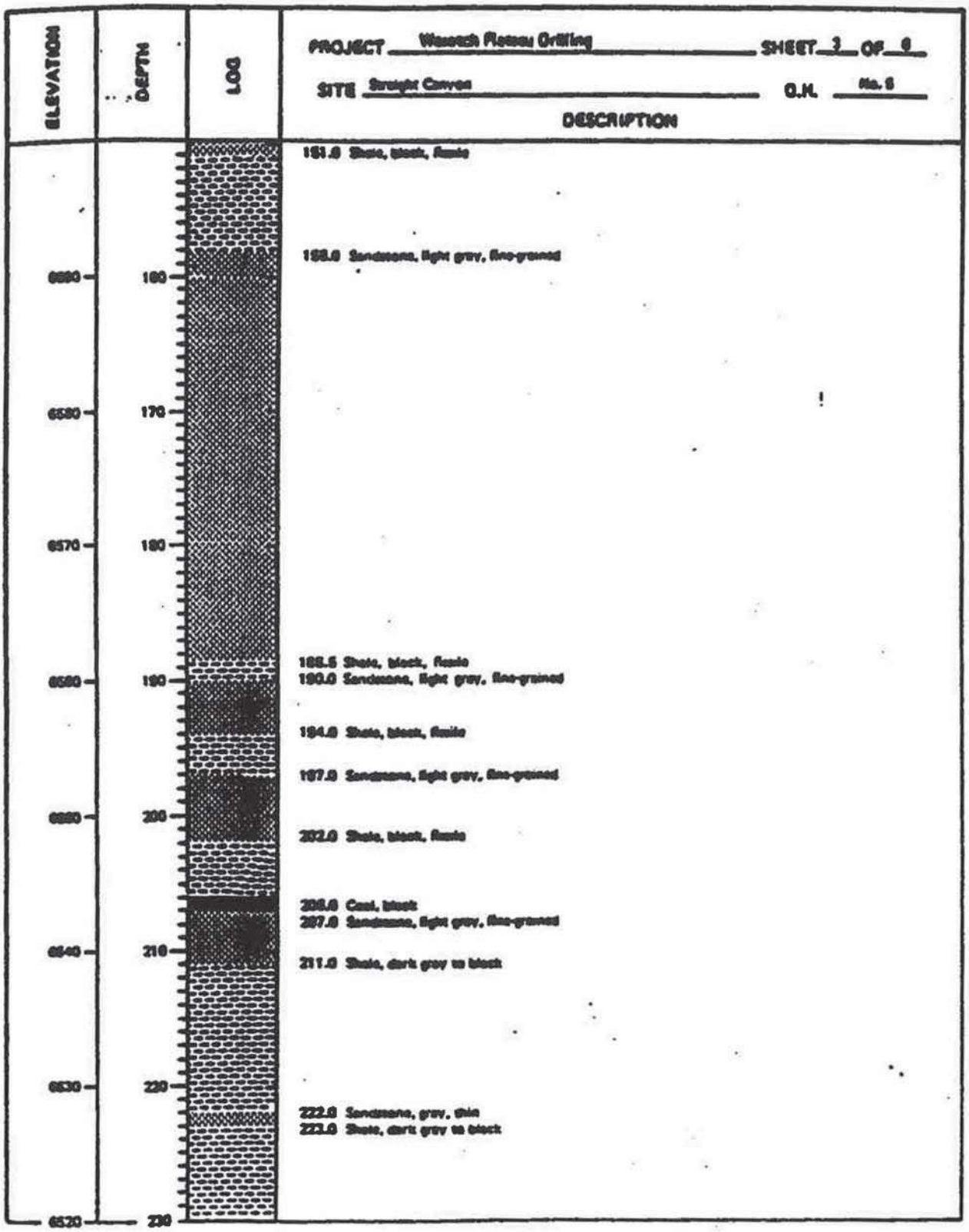
BEGAN July 7, 1976 COMPLETED July 12, 1976 TOTAL DEPTH OF HOLE 460.0 feet

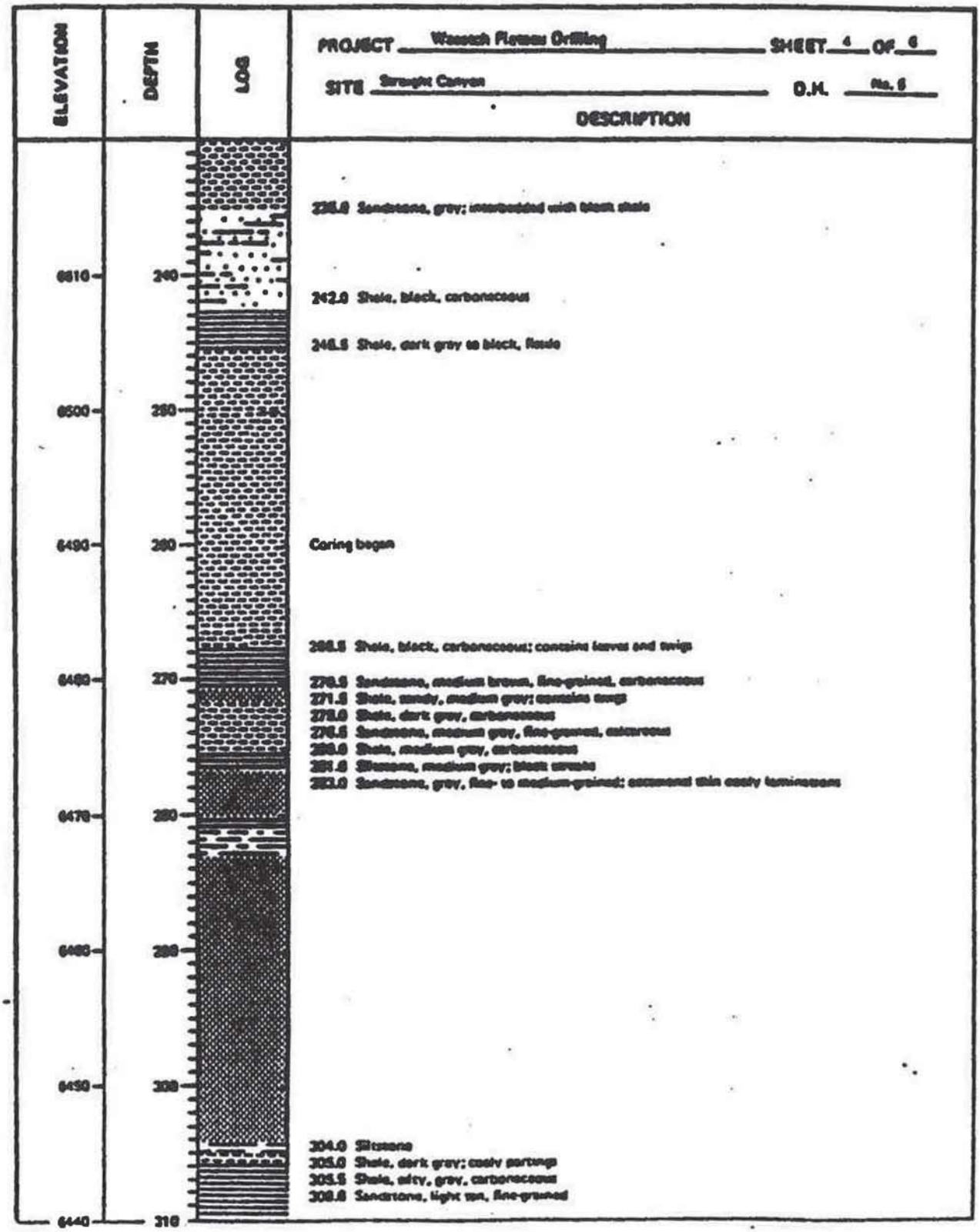
CORE RECOVERY (%) 100 FEET 200 feet GROUND ELEVATION 6,760 feet

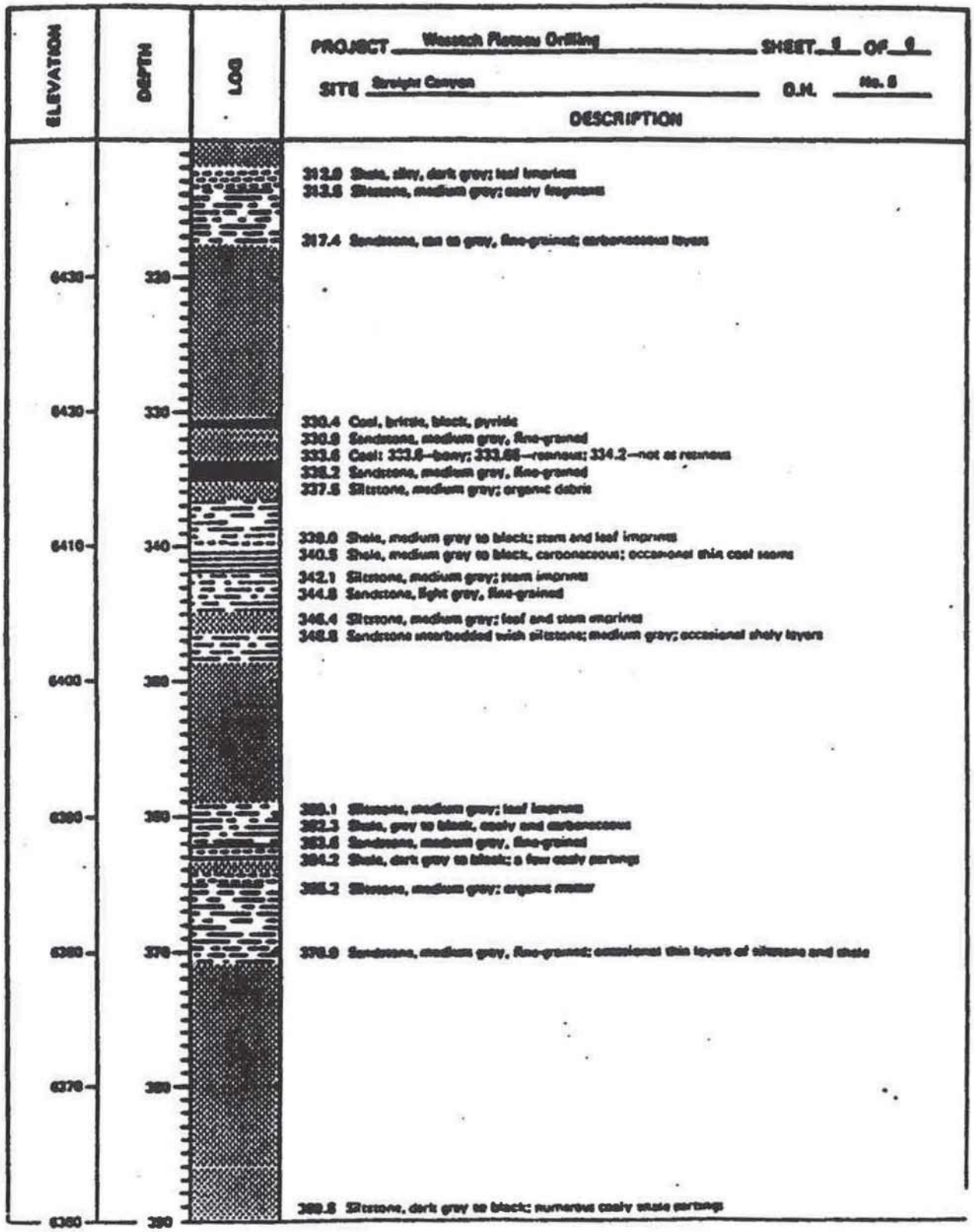
HOLE LOGGED BY H. Doelling, F. Gunn, L. Green DRILLER Boyles Brothers DRILL HOLE No. 5

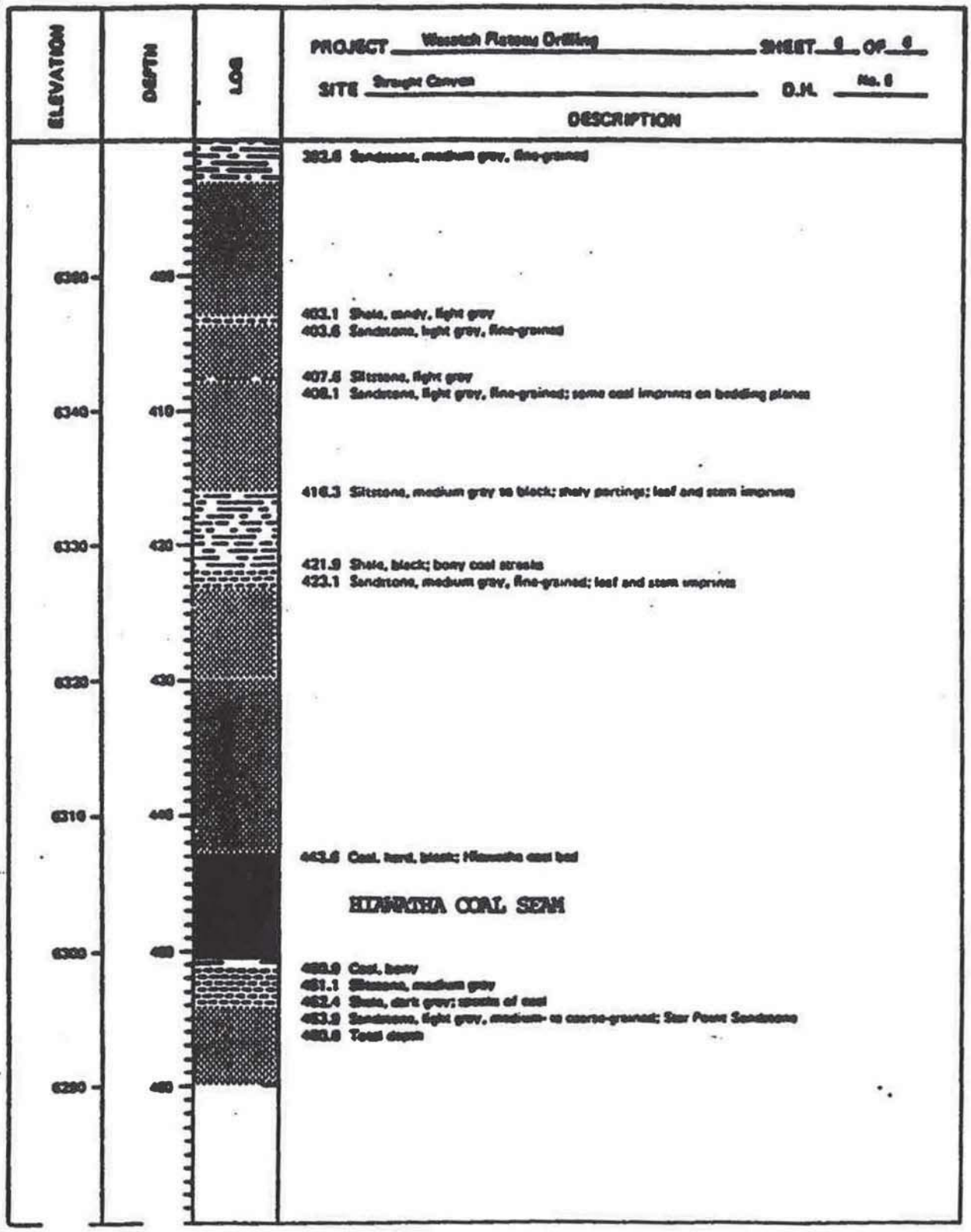



ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 3 OF 9
SITE Straight Canyon
D.H. No. 9
DESCRIPTION
71.0 Sandstone, light grey, fine-grained
83.0 Shale, black, fissile
92.0 Sandstone, light grey, fine-grained
96.0 Sandstone, grey; interbedded with dark grey shale
102.0 Shale, black, carbonaceous
107.0 Coal, black
108.5 Shale, dark grey, fissile
118.0 Sandstone, light grey, fine-grained
122.0 Shale, dark grey, fissile
126.5 Sandstone, light grey, fine-grained
145.0 Shale, black, fissile
146.5 Sandstone, light grey, fine-grained
6670
6660
6650
6640
6630
6620
6610
6600
80
90
100
110
120
130
140
150


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 3 OF 9
SITE Straight Canyon
O.H. No. 6
DESCRIPTION
181.8 Shale, black, fissile
188.8 Sandstone, light grey, fine-grained
6590
180
6580
170
6570
190
188.5 Shale, black, fissile
190.0 Sandstone, light grey, fine-grained
6560
194.8 Shale, black, fissile
197.0 Sandstone, light grey, fine-grained
6550
200
202.0 Shale, black, fissile
206.0 Coal, black
207.0 Sandstone, light grey, fine-grained
6540
210
211.0 Shale, dark grey to black
6530
220
222.0 Sandstone, grey, thin
223.0 Shale, dark grey to black
6520
230


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 4 OF 6
SITE Straight Canyon
D.H. No. 6
DESCRIPTION
6610
240
242.0 Shale, black, carbonaceous
246.5 Shale, dark gray to black, fissile
6500
260
6490
280
Coring began
286.5 Shale, black, carbonaceous; contains leaves and twigs
6480
270
270.5 Sandstone, medium brown, fine-grained, carbonaceous
271.5 Shale, sandy, medium gray; contains twigs
278.0 Shale, dark gray, carbonaceous
276.5 Sandstone, medium gray, fine-grained, calcareous
280.0 Shale, medium gray, carbonaceous
281.5 Siltstone, medium gray; black streaks
283.0 Sandstone, gray, fine- to medium-grained; contains thin coaly laminations
6470
280
6460
290
6450
300
304.0 Siltstone
305.0 Shale, dark gray; coaly partings
305.5 Shale, silty, gray, carbonaceous
308.0 Sandstone, light tan, fine-grained
6440
310


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling SHEET 9 OF 9
SITE Straight Canyon D.H. No. 8
DESCRIPTION
312.0 Shale, silty, dark gray; leaf imprints
313.6 Siltstone, medium gray; coaly fragments
317.4 Sandstone, tan to gray, fine-grained; carbonaceous layers
6430
320
6420
330
330.4 Coal, brittle, black, pyritic
330.8 Sandstone, medium gray, fine-grained
333.6 Coal: 333.6–bony; 333.88–rashaus; 334.2–not as resinous
336.2 Sandstone, medium gray, fine-grained
337.5 Siltstone, medium gray; organic debris
6410
340
338.0 Shale, medium gray to black; stem and leaf imprints
340.5 Shale, medium gray to black, carbonaceous; occasional thin coal seams
342.1 Siltstone, medium gray; stem imprints
344.8 Sandstone, light gray, fine-grained
346.4 Siltstone, medium gray; leaf and stem imprints
348.8 Sandstone interbedded with siltstone; medium gray; occasional shaly layers
6400
360
6390
350.1 Siltstone, medium gray; leaf imprints
352.3 Shale, gray to black, coaly and carbonaceous
353.6 Sandstone, medium gray, fine-grained
354.2 Shale, dark gray to black; a few coaly partings
355.2 Siltstone, medium gray; organic matter
6380
370
376.9 Sandstone, medium gray, fine-grained; occasional thin layers of siltstone and shale
6370
380
6360
390
389.8 Siltstone, dark gray to black; numerous coaly shale partings


ELEVATION
DEPTH
LOG
PROJECT Wasatch Plateau Drilling
SHEET 9 OF 9
SITE Straight Canyon
D.H. No. 6
DESCRIPTION
382.6 Sandstone, medium gray, fine-grained
6360
400
403.1 Shale, sandy, light gray
403.6 Sandstone, light gray, fine-grained
407.6 Siltstone, light gray
408.1 Sandstone, light gray, fine-grained; some coal impurities on bedding planes
6340
410
416.3 Siltstone, medium gray to black; shaly partings; leaf and stem imprints
6320
420
421.9 Shale, black; bony coal streaks
423.1 Sandstone, medium gray, fine-grained; leaf and stem imprints
6300
440
443.6 Coal, hard, blocky; Hiawatha coal bed
HIAWATHA COAL SEAM
6280
460
460.9 Coal, bony
461.1 Siltstone, medium gray
462.4 Shale, dark gray; stringers of coal
463.9 Sandstone, light gray, medium- to coarse-grained; Star Point Sandstone
480.0 Total depth
6260

# REPORT OF WATER OBSERVED

**Company:** PacifiCorp-Energy West
**Address:** P. O. Box 1005
Huntington, UT 84528

**Lease/License Number:** UTU-69956
**Drill Hole Number:** TM-3 (UGMS-5)
**Date Completed:** 9/30/93
**Total Depth:** 560'

**Company Contact:** Charles A. Semborski
**Phone Number:** (801) 653-2312

**Drilling Contractor:** Bob Beeman Drilling Company
**Address:** P. O. Box 788
Moab, UT 84532

**Company Contact:** Bob Beeman
**Phone Number:** (801) 259-7281

**Location of Hole:** T. 18S., R. 6 E., Section 3 : SW 1/4 NW 1/4 1/4
**Hole Elevation:** Est. 6750' **Hole Diameter:** 8-3/4"
**Drilling Method:** Rotary-Water
**Static Water Level:** Artesian Flow - 58 psi

Developed for monitoring. See well installation and lithologic log.

**Aquifer No. 1**
**Depth Below Ground Elevation:** 455-560' **Formation:** Starpoint Sandstone
**Rock Type:** Sandstone **Yield(GPM):** 12-18 GPM
**Date Reported to BLM*:** 9/30/93 **Requirements of BLM*:**
**Water Sample Provided to BLM?** No

**Aquifer No. 2**
**Depth Below Ground Elevation:** **Formation:**
**Rock Type:** **Yield(GPM):**
**Date Reported to BLM*:** **Requirements of BLM*:**
**Water Sample Provided to BLM?**

**Aquifer No. 3**
**Depth Below Ground Elevation:** **Formation:**
**Rock Type:** **Yield(GPM):**
**Date Reported to BLM*:** **Requirements of BLM*:**
**Water Sample Provided to BLM?**

---*

*Refer to Stipulation Number 3

# PACIFICORP ELECTRIC OPERATIONS
## FUEL RESOUCES
## MONITORING WELL INSTALLATION LOG

| | | | |
|---|---|---|---|
| JOB NO. | PROJECT Trail Mountain - Straight Canyon | WELL NO. TM-5 (USGS-5) | SHEET 1 |
| HYDROLOGIST Sprinkel | DRILLING METHOD Rotary - Mud | GROUND ELEV. 6750' Est | WATER DEPTH Artesian 38' Est |
| WEATHER Clear 10's | DRILLING CO. Rob Redman Drilling Co. | COLLAR ELEV. 6752' Est | DATE/TIME 9/30/93 |
| TEMP | DRILL RIG # | DRILLER Rob | STARTED 9/23/93 | COMPLETED 9/30/93 |

### MATERIALS INVENTORY

| | | | | | |
|---|---|---|---|---|---|
| WELL CASING | 4" LB. 0-505' feet | WELL SCREEN | 505' LB. 555' feet | BENTONITE SEAL | 455-465 |
| CASING TYPE | PVC Sch 40 | SCREEN TYPE | Circumslot PVC Sch 40 | INSTALLATION METHOD | Pour From Surface |
| JOINT TYPE | Flush - Treaded | SLOT SIZE | 20 SLOT | FILTER PACK QTY | 28 ft³ |
| GROUT QTY | 100 Bags | CENTRALIZERS | 503' & 556' | FILTER PACK TYPE | 8-12 Mesh |
| GROUT TYPE | Neat Cement | DRILLING MUD TYPE | — | INSTALLATION METHOD | Pour From Surface |
| LOCATION | NORTHING | EASTING | TOWNSHIP 18S | RANGE 6E | SECTION 3 |

| ELEV./DEPTH | SOIL/ROCK DESCRIPTION | WELL SKETCH | INSTALLATION NOTES |
|---|---|---|---|
| 50' | Top & Sub Soil 0-14' | | 2' Surface Casing w/ Lockable Lid |
| 100' | Blackhawk Formation See Lithology Log | | 12" Dia Hole to 95/8" Steel Casing |
| 150' | | | 8 3/4" Dia Hole |
| 200' | | | 4" PVC Sch 40 Trilok Treads |
| 250' | | | Water Level - Artesian Flow @ 12-18 GPM Pressure - 58 PSI |
| 300' | | | Cement Grout (100 Bags) BLM Representative Rom Passmussen |
| 350' | | | |
| 400' | | | |
| 450' | Hiawatha Seam | | Stainless Starlizers @ 503 and 556' |
| 500' | Starpoint Sandstone Upper Member - Spring Canyon | | Bentonite Chips 3/8 Pellets 455-465 |
| 550' | Interbedded Sandstone/ Mudstone | | Sand Pack 8-12 Mesh 28 ft³ 465-505 |
| 600' | | | Screen Zone 505-555' 20 Slot (Circumslot) |
| | | | 4" Riser PVC Sch 40 w/ End Cap 555-560 |

WL1

# WELL DRILLER'S REPORT
## State of Utah
## Division of Water Rights

For additional space, use "Additional Well Data Form" and attach

**Identification** MONITOR WELL: 93 - 93 - 001 - M TM-3

**Owner** *Note any changes*

PacifiCorp-Energy West
Box 1005
Huntington, UT 84528

Contact Person/Engineer: Charles A. Semborski

**Well Location** *Note any changes*

South 2500' East 1000' from NW corner of Section 3,
Township 18 South, Range 6 East, SLB&M
Elevation 6750'

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #) 11 miles NW of Orangeville, UT

**Drillers Activity** Start Date: 9/23/93 Completion Date: 9/30/93

Check all that apply:
[X] New [ ] Repair [ ] Deepen [ ] Abandon [ ] Replace [ ] Public Nature of Use: Monitoring Well

| DEPTH (feet) FROM | TO | BOREHOLE DIAMETER (in) | DRILLING METHOD | DRILLING FLUID |
|---|---|---|---|---|
| 0 | 20 | 12" | Rotary | Air |
| 20 | 560 | 8-5/8" | Rotary | Water w/polymer |
| | | | | |

**Well Log**

| DEPTH (feet) FROM | TO | WATER | PERMEABLE high | PERMEABLE low | UNCONSOLIDATED CLAY | SILT | SAND | GRAVEL | COBBLES | BOULDER | OTHER | CONSOLIDATED ROCK TYPE | COLOR | DESCRIPTIONS AND REMARKS (include comments on *water quality* if known.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | See attached Lithologic Logs |

**Static Water Level**

Date 9/30/93 Water Level 6886 est. feet Flowing? [X] Yes [ ] No

Method of Water Level Measurement Pressure Gauge If Flowing, Capped Pressure 58 PSI

Point to Which Water Level Measurement was Referenced Top of casing

Height of Water Level reference point above ground surface 2 feet Temperature 52 [ ] °C [X] °F

# APPENDIX 7-14(L)

# WATER RIGHTS

## APPENDIX 7-14(L)

## WATER RIGHTS

The following sheets list all known water rights in the vicinity of the Trail Mountain No. 9 Mine, including the Lease Application Area. Rights applicable to the permit and adjacent areas are underlined. Sheets 1,2 and 3 list rights by Water Right designation, with corresponding, applicable U.S. Forest Service water right designations listed to the side. The last 2 sheets show applicable U.S.F.S. water right designations.

Water rights are plotted on Figure 7-9 to show their relationship to the existing monitoring sites and projected mining angle-of-draw.

3/11/91

| NAME | SEC TOWN RANG BASE | APPLICATION NUMBER | CERTIFICATE NUMBER | WATER RIGHT NUMBER | STATUS/ TYPE | DIRECT SOURCE |
|---|---|---|---|---|---|---|
| Forest Service | 1 18S 6E SL | | | 93- 2115 | DIL | Surface Runoff WK |
| USA Forest Service | 1 18S 6E SL | | | 93- 3401 | DIL | Surface Runoff WK |
| USA Forest Service | 2 18S 6E SL | | | 93- 679 | DIL | Flag Lake Spring FS 108 |
| Bountiful City Corporation | 4 18S 6E SL | A56690 | | 93- 3173 | UNAP | Seely Creek |
| USA Forest Service | 4 18S 6E SL | | | 93- 630 | DIL | Surface Runoff |
| USA Forest Service | 4 18S 6E SL | | | 93- 627 | DIL | Surface Runoff |
| USA Bureau of Reclamation | 5 18S 6E SL | A13380 | | 93- 1003 | APP | Cottonwood Creek |
| USA Bureau of Reclamation | 5 18S 6E SL | a12551 | | 93- 980 | APP | Seely Creek |
| USA Bureau of Reclamation | 5 18S 6E SL | a14197 | | 93- 1003 | APP | Seeley Creek |
| USA Bureau of Reclamation | 5 18S 6E SL | a14198 | | 93- 952 | APP | Seeley Creek |
| USA Forest Service | 5 18S 6E SL | | | 93- 1600 | DIL | Straight Canyon Creek |
| USA Forest Service | 5 18S 6E SL | | | 93- 1597 | DIL | Straight Canyon Creek |
| Utah Power & Light Company | 5 18S 6E SL | A56668 | | 93- 3169 | UNAP | Cottonwood Creek-Joes Valley Res. |
| Western Hydro Electric Incorporated | 5 18S 6E SL | A56518 | | 93- 3204 | UNAP | Joes Valley Reservoir |
| Fail, Vaughn | 7 18S 6E SL | A10761 | | 93- 965 | CERT | Swasey Creek |
| Fail, Vaughn | 7 18S 6E SL | D3276 | | 93- 573 | DIL | Fuller Creek |
| Fail, Vaughn & Enid | 7 18S 6E SL | | | 93- 686 | DIL | Fork of Swasey Creek |
| , Vaughn and Enid | 7 18S 6E SL | | | 93- 681 | DIL | Swasey Creek |
| Fail, Vaughn and Enid | 7 18S 6E SL | | | 93- 680 | DIL | Fuller Creek |
| USA Forest Service | 7 18S 6E SL | | | 93- 669 | DIL | Swasey Creek |
| USA Forest Service | 9 18S 6E SL | | | 93- 631 | DIL | Birch Spring #1 |
| USA Forest Service | 12 18S 6E SL | | | 93- 1599 | DIL | Straight Canyon Creek FS 190 |
| USA Forest Service | 12 18S 6E SL | | | 93- 1596 | DIL | Straight Canyon Creek FS-193 |
| USA Forest Service | 13 18S 6E SL | | | 93- 658 | DIL | Surface Runoff |
| USA Forest Service | 13 18S 6E SL | | | 93- 1598 | DIL | Clay Banks Swale |
| USA Forest Service | 14 18S 6E SL | | | 93- 644 | DIL | Surface Runoff |
| USA Forest Service | 14 18S 6E SL | | | 93- 645 | DIL | Neilson Seep #1 |
| USA Forest Service | 15 18S 6E SL | | | 93- 642 | DIL | Corral Spring |
| USA Forest Service | 15 18S 6E SL | | | 93- 643 | DIL | Crawford Trail Spring |
| USA Forest Service | 16 18S 6E SL | | | 93- 632 | DIL | Unnamed Spring |
| USA Forest Service | 16 18S 6E SL | | | 93- 633 | DIL | Birch Spring #2 |
| USA Forest Service | 17 18S 6E SL | | | 93- 626 | DIL | Surface Runoff |
| USA Forest Service | 17 18S 6E SL | | | 93- 664 | DIL | North Dragon Creek |

| NAME / SEC TOWN RANG BASE | APPLICATION NUMBER | CERTIFICATE NUMBER | WATER RIGHT NUMBER | STATUS/ TYPE | DIRECT SOURCE |
|---|---|---|---|---|---|
| Cottonwood Creek Consolidated Irrigation Company<br>17 17S 6E SL | | | 93- 2148 | DEC | Indian Creek |
| Cottonwood Creek Consolidated Irrigation Company<br>17 17S 6E SL | | | 93- 2147 | DEC | Indian Creek |
| Cottonwood Creek Consolidated Irrigation Company<br>17 17S 6E SL | | | 93- 2151 | DEC | Indian Creek |
| Wilberg, Edna M. (et al.)<br>17 17S 6E SL | | | 93- 2927 | DIL | Lunch Hour Spring |
| Wilberg, Rufus B. (et al.)<br>17 17S 6E SL | | | 93- 789 | DIL | Indian Creek |
| Anderson, Bruce K.<br>18 17S 6E SL | E2116 | | 93-AREA | APP | Underground Water Well |
| Fillmore, Norman and Reva<br>18 17S 6E SL | | | 93- 793 | DIL | Lowry Fork Creek |
| Guymon, Darwin D.<br>18 17S 6E SL | E2254 | | 93-AREA | APP | Underground Water Well |
| Huntington, LeRay<br>18 17S 6E SL | E2114 | | 93-AREA | APP | Underground Water Well |
| Ruggeri, Pete J.<br>18 17S 6E SL | E2115 | | 93-AREA | APP | Underground Water Well |
| Wilberg, Rufus B. (et al.)<br>18 17S 6E SL | | | 93- 812 | DIL | Lowry Creek |
| Wilberg, Rufus B. (et al.)<br>18 17S 6E SL | | | 93- 796 | DIL | Spring |
| Wilberg, Rufus B. (et al.)<br>18 17S 6E SL | | | 93- 792 | DIL | Lowry Fork Creek |
| Cottonwood Creek Consolidated Irrigation Company<br>19 17S 6E SL | | | 93- 2154 | DEC | Lowry Creek |
| Cottonwood Creek Consolidated Irrigation Company<br>19 17S 6E SL | | | 93- 2153 | DEC | Lowry Creek |
| Cottonwood Creek Consolidated Irrigation Company<br>19 17S 6E SL | | | 93- 2157 | DEC | Reeder Creek |
| Cottonwood Creek Consolidated Irrigation Company<br>19 17S 6E SL | | | 93- 2156 | DEC | Reeder Creek |
| Cottonwood Creek Consolidated Irrigation Company<br>19 17S 6E SL | | | 93- 2152 | DEC | Lowry Creek |
| Cottonwood Creek Consolidated Irrigation Company<br>19 17S 6E SL | | | 93- 2155 | DEC | Reeder Creek |
| Kurtz, Robert E.<br>19 17S 6E SL | E2122 | | 93-AREA | APP | Underground Water Well |
| USA Forest Service<br>19 17S 6E SL | A18875 | 4140 | 93- 1022 | CERT | Lowry Creek |
| USA Forest Service<br>19 17S 6E SL | A18874 | 4139 | 93- 1021 | CERT | Reeder Creek |
| Wall and Wall (A Professional Corporation)<br>19 17S 6E SL | E2506 | | 93-AREA | REJ | Underground Water Well |
| USA Forest Service<br>21 17S 6E SL | | | 93- 2117 | DIL | Muddy Spring — 426 FS |
| USA Forest Service<br>22 17S 6E SL | | | 93- 696 | DIL | Teds Spring — 122 FS |
| USA Forest Service<br>23 17S 6E SL | | | 93- 697 | DIL | Paradise Canyon Spring 123 FS |
| USA Forest Service<br>24 17S 6E SL | | | 93- 699 | DIL | Roans Spring #1 124 FS |
| USA Forest Service<br>24 17S 6E SL | | | 93- 700 | DIL | Roans Spring #2 125 FS |
| Natomas Trail Mountain Coal Co.<br>25 17S 6E SL | E2137 | | 35-AREA | APP | Cottonwood Creek |
| Trail Mountain Coal Ltd.<br>25 17S 6E SL | | | 93- 709 | DIL | Cottonwood Creek |
| USA Forest Service<br>25 17S 6E SL | | | 93- 1594 | DIL | Cottonwood Creek 188 - FS |
| W. K. Minerals, Inc.<br>25 17S 6E SL | E2402 | | 93-AREA | APP | Underground water well |
| USA Forest Service<br>26 17S 6E SL | | | 93- 1595 | DIL | Pine Spring Creek 116 - FS |

| NAME / SEC TOWN RANG BASE | APPLICATION NUMBER | CERTIFICATE NUMBER | WATER RIGHT NUMBER | STATUS/ TYPE | DIRECT SOURCE | |
|---|---|---|---|---|---|---|
| USA Forest Service<br>26 17S 6E SL | | | 93- 689 | DIL | Pine Creek Spring | FS-115 |
| USA Forest Service<br>26 17S 6E SL | | | 93- 691 | DIL | Miles Spring #2 | FS-117 |
| USA Forest Service<br>26 17S 6E SL | | | 93- 690 | DIL | Miles Spring #1 | FS-116 |
| USA Forest Service<br>27 17S 6E SL | | | 93- 695 | DIL | Surface Runoff | FS-118 |
| USA Forest Service<br>27 17S 6E SL | | | 93- 692 | DIL | Surface Runoff | FS-121 |
| USA Forest Service<br>27 17S 6E SL | | | 93- 693 | DIL | North Flag Lake Point Spring | FS 119 |
| USA Forest Service<br>28 17S 6E SL | | | 93- 694 | DIL | Surface Runoff | FS-120 |
| Olsen, Arthur Delon & Henning J.<br>31 17S 6E SL | A8125 | 2036 | 93- 622 | CERT | Black Canyon Creek | |
| Strate, Abram C. (et al.)<br>31 17S 6E SL | A8125 | 2036 | 93- 945 | CERT | Black Canyon Creek | |
| USA Bureau of Reclamation<br>31 17S 6E SL | A11308 | 2151 | 93- 980 | CERT | Seely Creek | |
| Wilberg, Edna M. (et al.)<br>31 17S 6E SL | A8125 | 2036 | 93- 620 | CERT | Black Canyon Creek | |
| Wilberg, Wayne R.<br>31 17S 6E SL | A8124 | 2036 | 93- 582 | CERT | Black Canyon Creek | |
| Mussatt, James<br>32 17S 6E SL | E2437 | | 93-AREA | APP | Cottonwood Creek | |
| USA Forest Service<br>32 17S 6E SL | | | 93- 3374 | DIL | Unnamed Spring | |
| World, Jack<br>32 17S 6E SL | E1631 | | 93-AREA | APP | Underground Water Well | |
| USA Forest Service<br>35 17S 6E SL | | | 93- 687 | DIL | East Flag Lake Rim Spring | FS114 |
| USA Forest Service<br>35 17S 6E SL | | | 93- 685 | DIL | Marinus Ridge Spring | FS113 |
| USA Forest Service<br>35 17S 6E SL | | | 93- 683 | DIL | Surface Runoff | FS 111 |
| USA Forest Service<br>35 17S 6E SL | | | 93- 684 | DIL | Flag Lake Spring #1 | 112 FS |
| State of Utah Division of State Lands & Forestry<br>36 17S 6E SL | | | 93- 710 | DIL | Cottonwood Creek | |
| USA Forest Service<br>1 16S 6E SL | | | 93- 191 | DIL | Crandall Canyon Creek | |
| USA Forest Service<br>1 16S 6E SL | | | 93- 1409 | DIL | Crandall Canyon Spring | |
| State of Utah Division of State Lands & Forestry<br>2 16S 6E SL | | | 93- 383 | DIL | Crandall Canyon Creek | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1585 | DIL | Spoon Creek Spring #11 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1575 | DIL | Spoon Creek Spring #20 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1577 | DIL | Spoon Creek Spring #18 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1576 | DIL | Spoon Creek Spring #19 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1589 | DIL | Spoon Creek Spring #7 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1584 | DIL | Spoon Creek Spring #12 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1586 | DIL | Spoon Creek Spring #9 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1574 | DIL | Spoon Creek Spring #21 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1578 | DIL | Spoon Creek Spring #17 | |
| USA Forest Service<br>3 16S 6E SL | | | 93- 1639 | DIL | Bald Ridge Trough Spring #2 | |

FINDS USES WITHIN TOWNSHIP AND RANGE

USFS

| WTRSHD | USE_ID | SUBDIVISION | SECTION | TWNSHP | | RANGE | | USE_NAME | SOURCE_NAME | SOURCE_TRB |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 0050 | 14 | 19 | 180 | S | 060 | E | SPR STOCK WA | BUBS SPR NO1 | |
| 5 | 0055 | 12 | 18 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0056 | 01 | 31 | 180 | S | 060 | E | SPR STOCK WA | SEEP NO 1 | |
| 5 | 0057 | 12 | 31 | 180 | S | 060 | E | TR STOCK WAL | ONE PINE SP | |
| 5 | 0058 | 16 | 31 | 180 | S | 060 | E | SPR STOCK WA | LAMBNG GR SP | |
| 5 | 0059 | 14 | 32 | 180 | S | 060 | E | TR STOCK WAN | DRAGN SPR | |
| 5 | 0060 | 12 | 29 | 180 | S | 060 | E | TR STOCK WA | WILDCAT SPR | |
| 5 | 0061 | 03 | 17 | 180 | S | 060 | E | TR STOCK WAT | UTTLES SPR | |
| 5 | 0062 | 09 | 17 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0063 | 13 | 04 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0064 | 15 | 04 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0065 | 04 | 09 | 180 | S | 060 | E | SPR STOCK WA | BIRCH SPR | |
| 5 | 0066 | 03 | 16 | 180 | S | 060 | E | TR STOCK WA | UNNAMED SPR | |
| 5 | 0067 | 06 | 16 | 180 | S | 060 | E | TR STOCK WA | BIRCH SP | |
| 5 | 0068 | 12 | 33 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0069 | 01 | 21 | 180 | S | 060 | E | SPR STOCK WA | COX SEEP NO1 | |
| 5 | 0070 | 12 | 27 | 180 | S | 060 | E | SPR STOCK WA | CAPS SEEP N1 | |
| 5 | 0071 | 11 | 27 | 180 | S | 060 | E | SPR STOCK WA | CAPS SPR NO1 | |
| 5 | 0072 | 03 | 27 | 180 | S | 060 | E | SPR STOCK WA | CAPS SPR NO2 | |
| 5 | 0073 | 15 | 22 | 180 | S | 060 | E | SPR STOCK WA | CAPS SPR NO3 | |
| 5 | 0074 | 14 | 22 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0075 | 04 | 22 | 180 | S | 060 | E | SPR STOCK WA | COX SEEP NO2 | |
| 5 | 0076 | 06 | 15 | 180 | S | 060 | E | TR STOCK WA | CORRAL SPR | |
| 5 | 0077 | 08 | 15 | 180 | S | 060 | E | TR STOCK WA | CRWFRDTRL SP | |
| 5 | 0078 | 07 | 14 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0079 | 16 | 14 | 180 | S | 060 | E | SPR STOCK WA | NEILSON SEP1 | |
| 5 | 0081 | 07 | 23 | 180 | S | 060 | E | SPG STOCK WA | GREENGRASSE | |
| 5 | 0082 | 10 | 23 | 180 | S | 060 | E | SPG STOCK WA | REID NLSN SP | |
| 5 | 0083 | 09 | 25 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0084 | 04 | 25 | 180 | S | 060 | E | SPG STOCK WA | REYNOLDS SPG | |
| 5 | 0085 | 03 | 25 | 180 | S | 060 | E | SPG STOCK WA | CLAY BKS SEP | |
| 5 | 0086 | 01 | 25 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0087 | 14 | 24 | 180 | S | 060 | E | SPG STOCK WA | CLAY BKS SEP | |
| 5 | 0088 | 14 | 24 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0089 | 16 | 24 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0090 | 01 | 24 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0091 | 15 | 13 | 180 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0098 | 06 | 17 | 180 | S | 060 | E | STR STOCK WA | NORTH DRGNCR | |
| 5 | 0100 | 13 | 07 | 180 | S | 060 | E | STR STOCK WA | SWASEY CREEK | |
| 5 | 0101 | 02 | 07 | 180 | S | 060 | E | STR STOCK WA | SWASEY CREEK | |
| 5 | 0108 | 02 | 02 | 180 | S | 060 | E | SPG STOCK WA | FLAG LKE SPG | |
| 5 | 0109 | 07 | 01 | 180 | S | 060 | E | PD STOCK WAS | URF RUNOFF | |
| 5 | 0110 | 03 | 01 | 180 | S | 060 | E | PD STOCK WAS | URF RUNOFF | |
| 5 | 0190 | 01 | 12 | 180 | S | 060 | E | STR STOCK WA | STGHT CANYON | |
| 5 | 0191 | 03 | 11 | 180 | S | 060 | E | STR STOCK WA | SIGHT CANYON | |
| 5 | 0192 | 11 | 13 | 180 | S | 060 | E | STR STOCK WA | CLAYBKSSWALE | |
| 5 | 0193 | 01 | 12 | 180 | S | 060 | E | STR STOCK WA | STGHT CANYON | |
| 5 | 0194 | 03 | 11 | 180 | S | 060 | E | STR STOCK WA | STGHT CANYON | |
| 5 | 0196 | 12 | 08 | 180 | S | 060 | E | NDRGN RECARA | UNKNOWN SRCE | |

FINDS USES WITHIN TOWNSHIP AND RANGE

USFS

| WTRSHD | USE_ID | SUBDIVISION | SECTION | TWNSHP | | RANGE | | USE_NAME | SOURCE_NAME | SOURCE_TRB |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 0703 | 08 | 01 | 170 | S | 060 | E | PINE SPR TRO | PINE SPRING | |
| 4 | 0704 | 16 | 01 | 170 | S | 060 | E | E MTN CAP PD | SURF RUNOFF | |
| 4 | 0827 | 01 | 01 | 170 | S | 060 | E | STR STOCK WA | WHETSTONE CR | |
| 5 | 0021 | 04 | 19 | 170 | S | 060 | E | JOESVALY IRR | REEDER CR | |
| 5 | 0022 | 01 | 19 | 170 | S | 060 | E | JOES VLY IRR | LOWRY CR | |
| 5 | 0111 | 12 | 35 | 170 | S | 060 | E | PD STOCK WAS | URF RUNOFF | |
| 5 | 0112 | 11 | 35 | 170 | S | 060 | E | SPG STOCK WA | FLAG LKSPG1 | |
| 5 | 0113 | 05 | 35 | 170 | S | 060 | E | SPG STOCK WA | MARINUSRGESP | |
| 5 | 0114 | 07 | 35 | 170 | S | 060 | E | SPG STOCK WA | EFLLKRIM SP | |
| 5 | 0115 | 08 | 26 | 170 | S | 060 | E | SPG STOCK WA | PINE CR SPG | |
| 5 | 0116 | 06 | 26 | 170 | S | 060 | E | SPG STOCK WA | MILES SPG 1 | |
| 5 | 0117 | 06 | 26 | 170 | S | 060 | E | SPG STOCK WA | MILES SPG 2 | |
| 5 | 0118 | 10 | 27 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0119 | 14 | 27 | 170 | S | 060 | E | SPG STOCK WA | NFLGLK PTSPG | |
| 5 | 0120 | 07 | 28 | 170 | S | 060 | E | PD STOCK WAS | URF RUNOFF | |
| 5 | 0121 | 01 | 27 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0122 | 15 | 22 | 170 | S | 060 | E | SPG STOCK WA | TEDS SPRING | |
| 5 | 0123 | 11 | 23 | 170 | S | 060 | E | SPG STOCK WA | PARADISECNSP | |
| 5 | 0124 | 06 | 24 | 170 | S | 060 | E | SPG STOCK WA | ROANS SPG 1 | |
| 5 | 0125 | 06 | 24 | 170 | S | 060 | E | SPG STOCK WA | ROANS SPG 2 | |
| 5 | 0126 | 09 | 14 | 170 | S | 060 | E | SPG STOCK WA | COTTONWOODSP | |
| 5 | 0127 | 08 | 15 | 170 | S | 060 | E | SPG STOCK WA | NORTH PT SPG | |
| 5 | 0128 | 08 | 15 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0129 | 07 | 15 | 170 | S | 060 | E | SPG STOCK WA | COTTONWOODSP | |
| 5 | 0130 | 12 | 15 | 170 | S | 060 | E | SPG STOCK WA | TRAIL CYN 2 | |
| 5 | 0131 | 13 | 15 | 170 | S | 060 | E | SPG STOCK WA | BULL SPG | |
| 5 | 0132 | 01 | 21 | 170 | S | 060 | E | SPG STOCK WA | MUDDY SPRING | |
| 5 | 0135 | 16 | 09 | 170 | S | 060 | E | PD STOCK WAS | URF RUNOFF | |
| 5 | 0136 | 06 | 10 | 170 | S | 060 | E | SPG STOCK WA | INDIAN LGESP | |
| 5 | 0137 | 08 | 03 | 170 | S | 060 | E | SPG STOCK WA | MTNGHSECYNSP | |
| 5 | 0138 | 11 | 03 | 170 | S | 060 | E | SPG STOCK WA | DAIRY CYNSPG | |
| 5 | 0139 | 04 | 03 | 170 | S | 060 | E | SPG STOCK WA | SITTERUD SPG | |
| 5 | 0186 | 16 | 02 | 170 | S | 060 | E | STR STOCK WA | CTNWD CREEK | |
| 5 | 0187 | 16 | 25 | 170 | S | 060 | E | STR STOCK WA | CTNWD CREEK | |
| 5 | 0188 | 12 | 15 | 170 | S | 060 | E | STR STOCK WA | TRL CYN CK | |
| 5 | 0189 | 12 | 26 | 170 | S | 060 | E | STR STOCK WA | PINE SPG CR | |
| 5 | 0215 | 06 | 12 | 170 | S | 060 | E | SPG STOCK WA | DILLS SPRING | |
| 5 | 0217 | 08 | 12 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0220 | 09 | 12 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0221 | 09 | 12 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0222 | 08 | 12 | 170 | S | 060 | E | SPG STOCK WA | BRUCERANDSPG | |
| 5 | 0223 | 13 | 01 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0224 | 15 | 01 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0225 | 10 | 01 | 170 | S | 060 | E | SPG STOCK WA | PINE SPRING1 | |
| 5 | 0226 | 07 | 01 | 170 | S | 060 | E | PD STOCK WA | SURF RUNOFF | |
| 5 | 0578 | 05 | 01 | 170 | S | 060 | E | STR STOCK WA | HOGAN BSN CR | |

Query Data Entry

ENTER TOWNSHIP NO. (_10 TO _50): 170 ENTER FRACTIONAL TWP (_ OR 2):
ENTER TWP DIRECTION (N OR S): S ENTER RANGE NO. (__1 TO _26): 070
ENTER RANGE DIRECTION (E OR W): E

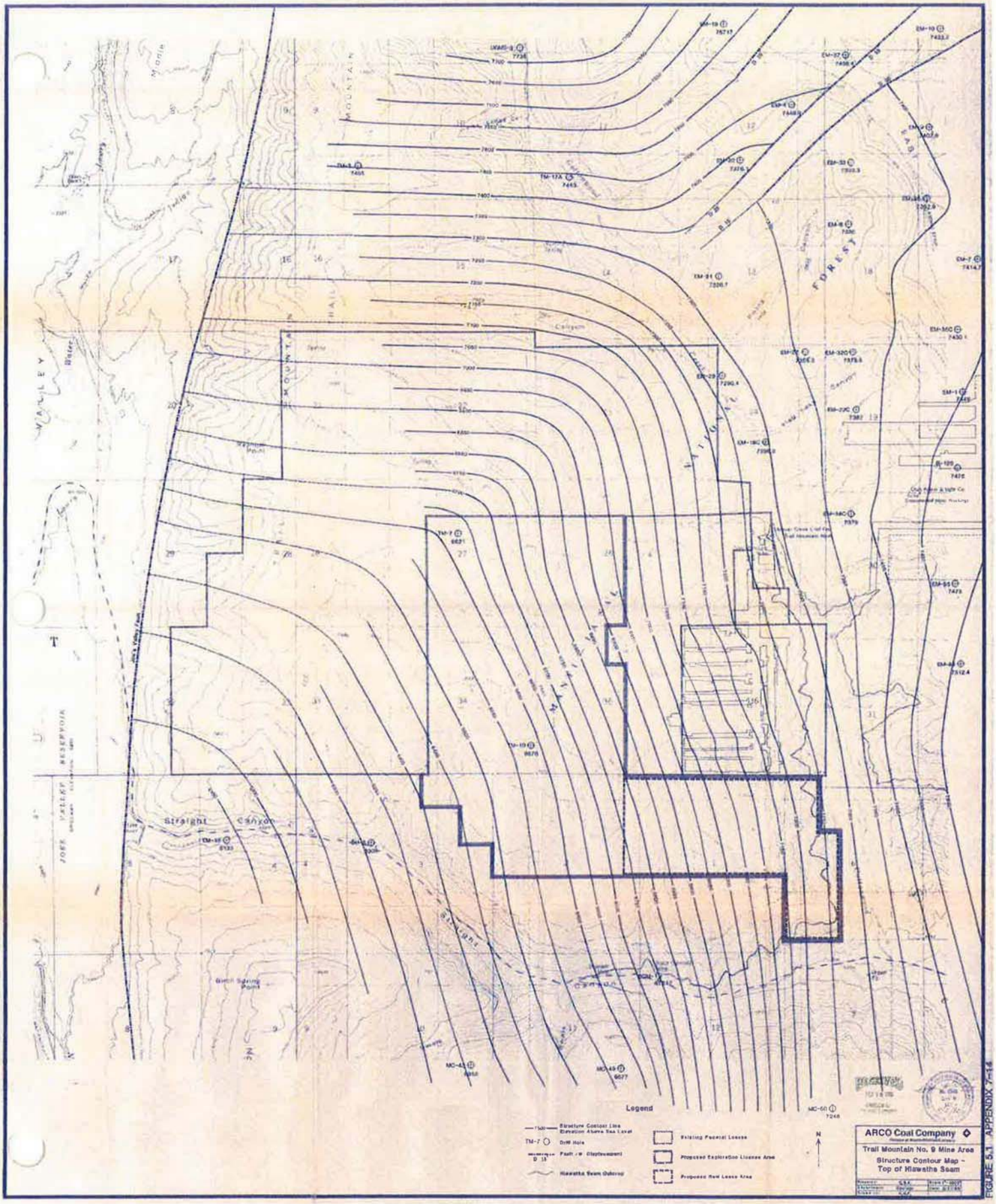



FIGURE 5.1 APPENDIX 7-14

# APPENDIX 7-15L

# DRILLHOLE WATER INFORMATION

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

APPENDIX 7-15(L)

DRILL HOLE

WATER INFORMATION

3/27/91

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Co.

**Address:** P.O. Box 1378

Price, Utah 84501

**Company Contact:** Kenneth S. Fleck (Geologist)

**Phone Number:** 801-637-5050 EX.25

**Lease/License Number:** STATE LEASE CEP U-49332 015/009/87A

**Drill Hole Number:** TM-DH-2

**Date Completed:** 7/12/88 - 7/21/88

**Total Depth:** 2,142'

**Drilling Contractor:** Himes Drilling Co., Inc.

**Address:** 2390 Highway 6 & 50

Grand Junction, Colorado

81505

**Company Contact:** Bud or Kevin Himes

**Phone Number:** 303-242-8893

**Location of Hole:** T. 17 S., R. 6 E., SLB&M, Section 26 : NW ¼ NE ¼ SE ¼

**Collar Elevation of Hole:** 9,175'

**Hole Diameters:** 12¼" 0 to 33' (10" casing)
9 7/8" 33' to 1064' (7" casing)
(Reamed 0 to 1064')
6¼" 1064' to 2064'
5" 2064' to 2102'
4 3/4" 2102' to 2142' (T.D.)

**Drilling Method/Medium:** Air/Foam

**Static Water Level:** 1,770'

Hole Dry 0-84, Damp 84' to 1064. After 1064' of 7" casing set, hole drilled dry 1064 to 1627', Damp 1627 to 2142'. No significant or productive aquifers encountered.

Acquifer #1

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

---

* Refer to Stipulation Number 3

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Co.

**Address:** P.O. Box 1378
Price, Utah 84501

**Lease/License Number:** UTU-64233

**Drill Hole Number:** TMX-1

**Date Completed:** 8/22/88 - 8/26/88

**Total Depth:** 1,581'

**Company Contact:** Kenneth S. Fleck (Geologist)

**Phone Number:** 801-637-5050 EXT.25

**Drilling Contractor:** Himes Drilling Co., Inc.

**Address:** 2390 Highway 6 & 50
Grand Junction, Colorado
81505

**Company Contact:** Bud or Kevin Himes

**Phone Number:** 303-242-8893

**Location of Hole:** T. 18 S., R. 6 E., SLB&M, Section 1 : SW ¼ NE ¼ NE ¼

**Collar Elevation of Hole:** 8,600'

**Hole Diameters:**
15" 0 to 41' (10" casing)
9 7/8" 41' to 452' (7" casing)
6¼" 452' to 760'
6 1/8" 760' to 1,460'
5" 1,460' to 1,520'
4 7/8" 1,520' to 1,581' (T.D.)

**Drilling Method/Medium:** Air to 1,460', Air/foam to T.D.

**Static Water Level:** None

Hole dry 0'to 452. After 450' of 7" casing set, hole drilled dry to 1,460'. Switched to air/foam 1,460' to 1,581' (Necessary for coring). No significant or productive aquifers encountered.

Acquifer #1

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

---

* Refer to Stipulation Number 3

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Company
**Address:** P.O. Box 1378
Price, Utah 84501

**Lease/License Number:** UTU-64233
**Drill Hole Number:** TMX-2
**Date Completed:** 8/5/89
**Total Depth:** 2,340'

**Company Contact:** Kenneth S. Fleck (Geologist)
**Phone Number:** (801) 637-5050 ext. 49

**Drilling Contractor:** Bob Beeman Drilling Co., Inc.
**Address:** P.O. Box 788
Moab, Utah 84532

**Company Contact:** Bob Beeman or Ted Christensen
**Phone Number:** (801) 259-7281

**Location of Hole:** T. 17 S., R. 6 E., SLB&M, Section 26 : NE¼ NE¼ SW¼
**Collar Elevation of Hole:** 9,150'
**Hole Diameter**
12 3/4" 0 - 210' (9 5/8" CASING)
8 3/4" 210 - 1240' (7" CASING)
6 3/4" 1240' - 2240'
5" 2240 - 2317.5'
4 3/4" 2317.5 - 2340'

**Drilling Method/Medium:** AIR/FOAM 0-210' AIR/FOAM 210'-1240' REAMED W/MUD 0-1240'
DRY 1240-1720 AIR/FOAM TO T.D.

**Static Water Level:** NONE

HOLE DAMP 0 - 1240' AFTER 1137' 7" CASING SET, HOLE DRILLED DRY 1240 - 1720'. SWITCHED TO AIR/FOAM AT 1720' DRILLED AIR/FOAM 1720' TO T.D. NO SIGNIFICANT AQUIFERS ENCOUNTERED

Acquifer #1

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

---

* Refer to Stipulation Number 3

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Co. **Lease/License Number:** UTU-64233

**Address:** P.O. Box 1378 **Drill Hole Number:** TMX-3

Price, Utah 84501 **Date Completed:** 09/28/83 - 10/13/88

**Total Depth:** 2,220'

**Company Contact:** Kenneth S. Fleck (Geologist)

**Phone Number:** 801-637-5050 EXT.25

**Drilling Contractor:** Himes Drilling Co., Inc.

**Address:** 2390 Highway 6 & 50

Grand Junction, Colorado

81505

**Company Contact:** Bud or Kevin Himes

**Phone Number:** 303-242-3893

**Location of Hole:** T. 17 S., R. 6 E., SLB&M, Section 35 : NW ¼ NE ¼ NW ¼

**Collar Elevation of Hole:** 9,010' **Hole Diameters:** 15" 0 to 39' (10" casing)
S 7/8" 39' to 1051' (7" casing)
6¼" 1051 to 2,126'

**Drilling Method/Medium:** Air to 80'. Air/Foam to T.D. 5" 2126 to 2,200'
(Reamed 0 to 1051' with 4 3/4" 2,200' to 2,220' (T.D.)
Mud)

**Static Water Level:** 1,780'
Hole drilled dry to 80'. Hole V. wet 640' - 800'. After 1051' 7" casing set, hole drilled damp to 2,220'.

Acquifer #1

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

---

* Refer to Stipulation Number 3

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Company

**Address:** P.O. Box 1378

Price, Utah 84501

**Company Contact:** Kenneth S. Fleck

**Phone Number:** 801-637-5060 EXT. 25

**Drilling Contractor:** Himes Drilling Co. Inc.

**Address:** 2390 Highway 50 & 6

Grand Junction, Colorado

81505

**Company Contact:** Bud or Kevin Himes

**Phone Number:** 303-242-8893

**Lease/License Number:** UT-64233

**Drill Hole Number:** TMX-4

**Date Completed:** 9/3/88 - 9/27/88

**Total Depth:** 740'

LIST OF DRILLING EQUIP. LOST IN HOLE:

1 9½" Drill Bit (1')
1 Bit Sub (2')
3 7" Drill Collars (10'ea)
2 6" Drill Collars (10'ea)
6 4 3/4" Drill Collars (20'ea)
2 Collar Subs (2'ea)
2 Float Subs (1'ea)

Total String Length Approx 180'

**Location of Hole:** T.17 S., R. 6 E., SLB&M, Section 35 : SW ¼ SW ¼ SE ¼

**Collar Elevation of Hole:** 8,910' **Hole Diameters:** 15" 0-17' (10" casing)
9½" 17' - 740' (T.D.)

**Drilling Method/Medium:** Air 0 to 140' Air/Foam 140 to 740'

**Static Water Level:** NONE

Hole drilled dry 0-140'. Damp 140' - 740' Drill string stuck in hole at 740'. Hole abandoned after 48 hours fishing activity. No significant or productive Aquifers encountered.

Acquifer #1

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____

**Rock Type:** _____ **Yield(GPM):** _____

**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____

_____ **Water Sample Provided to BLM?** _____

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* Refer to Sec. 1 ...

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Company
**Address:** P.O. Box 1378
Price, Utah 84501

**Lease/License Number:** UTU-64233
**Drill Hole Number:** TMX-5
**Date Completed:** 7/21/89
**Total Depth:** 1,960'

**Company Contact:** Kenneth S. Fleck (Geologist)
**Phone Number:** (801) 637-5050 ext. 49

**Drilling Contractor:** Bob Beeman Drilling Co., Inc.
**Address:** P.O. Box 788
Moab, Utah 84532

**Company Contact:** Bob Beeman or Ted Christensen
**Phone Number:** (801) 259-7281

**Location of Hole:** T. 17 S., R. 6 E., SLB&M, Section 34 : SW¼ SW¼ NE¼
**Collar Elevation of Hole:** 8,402' **Hole Diameter** 12¼" 0 TO 20' (9⅝" CASING)
9⅞" 20 TO 760' (7" CASING)
6¼" 760' TO 1840'
5" 1840 TO 1960'
4¾" 1420' TO 1960'
**Drilling Method/Medium:** AIR TO 420' AIR/FOAM TO T.D.
**Static Water Level:** NONE

HOLE DRY 0 TO 420'. DAMP 420-760. AFTER 760' 7" CASING SET, HOLE DRILLED DRY TO SWITCHED TO AIR FOAM AT 1240'. DRILLED AIR/FOAM TO T.D. NO SIGNIFICANT AQUIFERS 1240.

Aquifer #1 ENCOUNTERED.

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

Aquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

---

* Refer to Stipulation Number 3

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Company
**Address:** P.O. Box 1378
Price, Utah 84501

**Lease/License Number:** UTU-64233
**Drill Hole Number:** TMX-6
**Date Completed:** 08/18/87
**Total Depth:** 2,440'

**Company Contact:** Kenneth S. Fleck (Geologist)
**Phone Number:** (801) 637-5050 ext. 49

**Drilling Contractor:** Bob Beeman Drilling Co., Inc.
**Address:** P.O. Box 788
Moab, Utah 84532

**Company Contact:** Bob Beeman or Ted Christensen
**Phone Number:** (801) 259-7281

**Location of Hole:** T. 17 S., R. 6 E., SLB&M, Section 27 : NE ¼ SE ¼ SW ¼
**Collar Elevation of Hole:** 8,485' **Hole Diameter** 12 3/4" 0' TO 210' (9 5/8" CASING)
8 3/4" 210' TO 1310' (7" CASING)
6 1/4" 1310 TO 2340'
5" 2340' TO 2440'
**Drilling Method/Medium:** AIR/FOAM 0' TO TD.

**Static Water Level:** NONE
HOLE DAMP 0-210'. AFTER 210' 9 5/8" CASING SET, HOLE DRILLED DRY TO 860. HOLE DAMP 860' TO 1310'. AFTER 1270' 7" CASING SET, HOLE DRILLED DRY TO 1660' HOLE DAMP 1660' TO T.D. NO SIGNIFICANT AQUIFERS ENCOUNTERED.
Acquifer #1

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

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* Refer to Stipulation Number 3

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Company
**Address:** P.O. Box 1378
Price, Utah 84501

**Lease/License Number:** UTU-64233
**Drill Hole Number:** TMX-7
**Date Completed:** 7/9/89
**Total Depth:** 1,854'

**Company Contact:** Kenneth S. Fleck (Geologist)
**Phone Number:** (801) 637-5050 ext. 49

**Drilling Contractor:** Bob Beeman Drilling Co., Inc.
**Address:** P.O. Box 788
Moab, Utah 84532

**Company Contact:** Bob Beeman or Ted Christensen
**Phone Number:** (801) 259-7281

**Location of Hole:** T. 17 S., R. 6 E., SLB&M, Section 34 : SE¼ SW¼ SE¼
**Collar Elevation of Hole:** 8294' **Hole Diameter:** 12 3/4" 0 TO 20' (9 5/8" CASING)
8 3/4" 20' TO 687' (7" CASING)
6 1/4" 687' TO 1,738'
5" 1738' TO 1837'
4 3/4" 1837' TO 1854' (T.D.)
**Drilling Method/Medium:** AIR TO 205' AIR/FOAM TO T.D.
**Static Water Level:** NONE
HOLE DRY 0' TO 205'. DAMP TO 687' AFTER 670' 7" CASING SET, HOLE DRILLED DRY TO 1,605'. HOLE DAMP 1605' TO T.D. SWITCHED TO AIR/FOAM AT 205' AND 1605'. NO SIGNIFICANT Acquifer #1 OR PRODUCTIVE AQUIFERS ENCOUNTERED.

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

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* Refer to Stipulation Number 3

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Company
**Address:** P.O. Box 1378
Price, Utah 84501

**Lease/License Number:** UTU-64233
**Drill Hole Number:** TMX-8
**Date Completed:** 6/30/89
**Total Depth:** 1,830'

**Company Contact:** Kenneth S. Fleck (Geologist)
**Phone Number:** (801) 637-5050 ext. 49

**Drilling Contractor:** Bob Beeman Drilling Co., Inc.
**Address:** P.O. Box 788
Moab, Utah 84532

**Company Contact:** Bob Beeman or Ted Christensen
**Phone Number:** (801) 259-7281

**Location of Hole:** T. 18 S., R. 6 E., SLB&M, Section 2 : SW¼ SE¼ NE¼
**Collar Elevation of Hole:** 8,462' EST. **Hole Diameter**
12 3/4" TO 20' (9 5/8" CASING)
8 3/4" 20' TO 566' (7" CASING)
6 1/4" 566' TO 1700'
5" 1700 TO 1776.5'
4 3/4" 1776.5' TO 1830' (TD)
**Drilling Method/Medium:** AIR TO 1,700' AIR/FOAM TO T.D.
**Static Water Level:** NONE

HOLE DRY 0' TO SEE. AFTER 566' OF 7" CASING SET, HOLE DRILLED DRY TO 1,700'. SWITCHED TO AIR/FOAM 1,700' TO 1,830' (NECESSARY FOR CORING). NO SIGNIFICANT OR PRODUCTIVE AQUIFERS ENCOUNTERED.

Acquifer #1

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

---

* Refer to Stipulation Number 3

# REPORT OF WATER OBSERVED

**Company:** Beaver Creek Coal Co.
**Address:** P.O. Box 1378
Price, Utah 84501

**Lease/License Number:** UTU-64233
**Drill Hole Number:** TMX-9
**Date Completed:** 8/27/88 - 8/29/88
**Total Depth:** 1,440'

**Company Contact:** Kenneth S. Fleck (Geologist)
**Phone Number:** 801-637-5050 EXT.25

**Drilling Contractor:** Himes Drilling Co. Inc.
**Address:** 2390 Highway 6 & 50
Grand Junction, Colorado 81505

**Company Contact:** Bud or Kevin Himes
**Phone Number:** 303-242-8893

**Location of Hole:** T.18 S., R.6 E., SLB&M, Section 1 : NE ¼ SE ¼ NW ¼
**Collar Elevation of Hole:** 8,290' **Hole Diameters:** 15" 0 to 20' (10" casing)
9 7/8" 20' to 33'
8¾" 33' to 1,340'
**Drilling Method/Medium:** Air to 1,340', Air/foam 1,340' to T.D. 5" 1340' to 1,440' (T.D.)

**Static Water Level:** NONE
Hole dry 0' to 1,340'. No intermediate casing set. Switched to air/foam 1,340' to 1,440' (T.D.), Necessary for coring. No significant or productive aquifers encountered.

Acquifer #1

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

Acquifer #2

**Depth below Collar Elevation:** _____ **Formation:** _____
**Rock Type:** _____ **Yield(GPM):** _____
**Date Reported to BLM:*** _____ **Requirements of BLM:*** _____
_____ **Water Sample Provided to BLM?** _____

---

* Refer to Stipulation Number 3

APPENDIX 7-16

PROPOSED PARKING LOT/CULVERT EXTENSION

**Errata Sheet Pertaining to Proposed Transfer of Permit From PacifiCorp to Fossil Rock Resources, LLC**

This sheet is to be placed at the beginning of Chapters 1 thru 12 of the Trail Mountain Permit C/015/0009, the associated binders containing appendices, tables, figures, drawings, maps and to remain until such time that the permit is transferred and amended to reflect the information for the new permittee, Fossil Rock Resources, LLC (Fossil Rock Mine). This sheet is to be placed in the Waste Rock Site binder at the beginning of sections containing text, appendices and maps.

The facilities have changed hands multiple times, which means there are various references in the text, reports, studies, right-of-ways, leases and laboratory analyses which refer to the company owning or operating the mine facilities during a specific period of time. To provide clarification the following table lists the various names used through the life of the permit (to the best of our knowledge) and what entity under the new ownership those references will refer to.

| Names Existing | Following Permit Transfer | |
|---|---|---|
| PacifiCorp | Fossil Rock Resources, LLC | |
| Beaver Creek Coal Company | | |
| Interwest Mining | | |
| Energy West Mining Company | | |
| Arco Mining | | |
| Arch Minerals | | |
| Ark Land | | |
| Trail Mountain Coal Company | | |
| Utah Power & Light Company | | |
| Utah Power & Light Mining Division | | |
| | | |
| | | |
| | | |
| Trail Mountain Mine | Fossil Rock Mine | |
| Trail Mountain Mine No. 9 | | |
| Cottonwood/Wilberg Waste Rock | | |
| Natomas Mine | | |
| Utah Power & Light Mining Division | | |
| Cottonwood Mine | | |
| Grimes Wash Facility | | |
| | | |
| | | |
| | | |
| | | |

When use of the above referenced names appear in the permit documents to describe events which would be considered historic they will remain the same. When the names are used to imply a commitment or ownership the names will be changed or amended where possible as designated in this table.

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**APPENDIX 7-16**

**TRAIL MOUNTAIN MINE**

**PROPOSED PARKING LOT/CULVERT EXTENSION**

General

The proposed project consists of extending the existing parking area approximately 87' to the North. This will require the extension of the Cottonwood Creek culvert for approximately 70'. This extension will allow the expansion of the parking area and facilitate the necessary parking space required to accommodafe the mine employees now assigned to work at this facility. The proposed plan includes burial of the culvert with Non-Toxic, Non-Acidity forming material. The existing headwall and wingwall configuration will be duplicated and the existing trash rack will be placed at the new inlet. The location of the proposed extension and cross-sections of the area are shown on the enclosed drawing No. TMS1599D, Figure 1.

Disturbed Area Increase

The proposed project will increase the existing surface runoff area reporting to the sediment pond by approximately 0.10 acres, as depicted on Drawing TMS1599D, figure 1. The actual disturbed area increase consists of 0.063 acres, as depicted on Figure 2, of this appendix. A portion ( 0.02 acres) B.T.C.A. is treated with silt fence. The remaining portion reports to the sediment pond.

Installation Procedure

The culvert installation will take place in the following manner:

( 1 ) A diversion dam will be constructed upstream of the proposed new inlet, to capture flow from the stream.

( 2 ) A 5 HP ( or larger ) pump will be placed upstream from the diversion dam, and will divert the stream flow through a 6" flexible line running across the county road and down the east road ditch to a 24" CMP culvert inlet. This culvert ties into the 66" culvert.

( 3 ) In the event of a major storm the diversion dam will be constructed so the water can overflow the dam, travel through the construction area and back into the existing culvert. However, it will only occur during a major storm event. The proposed location and diversion structures are shown on the attached drawings, Fig. 2 and 3, Appendix 7-16.

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( 4 ) Once the stream diversion is complete, the trash rack, rip-rap and headwall structures will be removed using a track-mounted backhoe. The concrete will be broken up and hauled to the Cottonwood Waste Rock Site. The rip-rap and trash rack will be stored for re-use.

( 5 ) Vegetation will then be removed and disposed of in an approved manner. ( Note: The area has been surveyed for nests of raptors and /or other high interest species. No nests have been observed in the construction area.)

( 6 ) Top soil will be removed and placed at the old Cottonwood Waste Rock Site. Seeding and curlex blanket will take place to prevent erosion.

( 7 ) The 96" to 66" x 38' CMP transition will be removed and stored for use at the proposed inlet.

( 8 ) The channel area will then be graded in preparation for placement of the culvert.

( 9 ) A bedding of not less than 12" of sand will be placed in the bottom of the channel, and smoothed for placement of the culvert.

(10) The culvert will then be installed up to and including the inlet, which includes a new 32' section of 66" CMP and the 38' x 96" to 66" transitional section.

(11) The backfill material will be placed along the culvert in lifts not to exceed 6", and will be mechanically tamped. This procedure will continue until the culvert is more than 1/2 buried. The completion of backfill and compacting will then be accomplished by utilizing 8" lifts and a vibratory compactor. The area will then be finished to the design grades providing proper drainage to the existing drainage system.

(12) The concrete inlet and wingwalls will be placed as soon as the culvert installation is completed.

(13) The diversion dam and pump will be removed. The fence and new disturbed area perimeter markers will be installed in the new location as depicted on drawing TMS1599D. Silt fence will be installed as necessary to treat any runoff that cannot be directed to the surface drainage control system. The area treated by silt fence will be identified as a B.T.C.A. area.

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Environmental Considerations

( 1 ) Disturbed Area

The project will disturb an area of approximately 0.066 acres of riparian habitat. Mitigation for this loss of riparian area is discussed later in this section.

( 2 ) Drainage Controls

a. Description -Drainage controls for this project will consist of temporary diversion measures described above. In addition, permanent drainage controls will be installed. These will consist of :

( 1 ) The extended culvert.

( 2 ) Grading and placement of asphalt paving, which will direct runoff toward the East side of the parking extension and the existing surface drainage system.

( 3 ) A berm will be installed along the West and North side of the extended parking area to control the disturbed runoff. ( See Dwg. TMS1599D )

( 4 ) Silt fence will be installed as necessary to treat any runoff that cannot be directed to the surface drainage control system. The area treated by silt fence will be identified as a B.T.C.A. area.

b. Additional Drainage - The additional drainage area to the sediment pond is shown on Drawing TMS1599D. This consists of approximately 0.10 acres of additional surface runoff area. Runoff from this area is calculated based on the 10 year -24 hour event. The precipitation depth from this event is 2.4 inches. The M.R.P. pond capacity figures are found on Table 7-9, 7-10. The calculations for the additional surface runoff found in Table 7-2, Appendix 7-16 indicate an increase of 0.02 acre feet reporting to the sediment pond. The sediment pond is of adequate size ( 2.24 acre ft., see Plate 7-8 ) to accommodate this additional runoff.

c. Map - Drainage controls are shown on the drawing TMS1362D, Figure 3-1 and TMS 1371D, Figure 7-5, Volume 3 and TMS 1599D, Figure 7-16A, Appendix 7-16.

d. Controls - Drainage controls for the culvert inlet will consist of concrete wingwalls, a trash rack, and rip-rap ( D50 = 18" + ). The parking lot extension will be graded to direct surface flows to the existing surface drainage system.

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( 3 ) Topsoil

The proposed disturbance is in the riparian area, designated as soil type R-1 in Chapter 8 of the M.R.P. The stream bank area is extremely steep and rocky, however, some topsoil can likely be salvaged by the use of a backhoe. It is estimated that an average depth of 16" of topsoil can be salvaged over 50% of the area, resulting in approximately 167 cubic yards of topsoil saved. Any recovered topsoil will be placed in an uncompacted state at the old Cottonwood Waste Rock Site and seeded.

( 4 ) Vegetation

All large, woody vegetation 6" DBH and larger will be removed from the area prior to salvage of topsoil. Smaller specimens will be mixed with the topsoil to provide organic material.

( 5 ) Wildlife

The area has been surveyed for nests of raptors and other high interest avian species. No nests have been observed in the area. No other impacts to wildlife are expected as a result of this project.

Several taxa of macroinvertebrates have been observed in the portion of the stream that will be affected by the proposed culvert/parking lot extension. These include Trichoptera, Ephemeropetra, Coleoptera and Diptera.

Considering the short length of stream that will be impacted,( 70' ) the conclusions of the 1986 study done by Dr. Dennis Shiozawa and the 1986 UDWR letter, which states "...mining is not likely a measurable influence on the stream system..." (see Appendix 10-7), are applicable. Therefore, impacts to macroinvertebrates, resulting from the culvert/parking lot extension will not be significant.

( 6 ) Dust Control

If dust should become a problem during construction the area will be watered as necessary.

( 7 ) Cultural/Historical/Archaeological Sites -

This area is not known to contain any sites of cultural, historical or archaeological significance. ( See Chapter 5 of the M.R.P. for studies and results.)

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Final Reclamation

Upon completion of operations, this area will be reclaimed in conjunction with the rest of the site. The culverts and all associated structures will be removed, the area will be upgraded, and the channel will be restored as described in Sections 3.5 and 7.4 of the M.R.P. The channel area will be restored according to the "Typical Reclaimed Channel" design shown in Figure 7-12 of the M.R.P. Upon completion of recontouring, the areas will be reseeded per the approved plan for permanent reclamation. In addition, Energy West Mining Co. will commit to transplanting 22 ten-gallon and 6 twenty-five gallon Cottonwood trees in the riparian area of this proposal. Topsoil from the topsoil storage pile will be used for reclamation of the riparian zone.

Other Agency Approvals Required

Since this proposal involves a perennial stream and riparian area, approvals must be obtained from the State Engineer's office and the Division of Wildlife Resources. Required forms and plans have been submitted to the State Engineers Office and an onsite review with the Division of Wildlife Resources has been conducted.

Construction Schedule

It is proposed to do this project during the fall of this year, when the period of lowest flow is in the stream. It is estimated that the project should commence between Sept. 1, and Oct. 15, 1996 and take approximately 30 days to complete, excluding the asphalt surface, which should be completed before a years time.

Mitigation of Riparian Area

Consultation regarding impact mitigation has been conducted with UDWR. The representative for the Division was Ben Morris, Price Office. Mitigation requirements will be determined by UDWR, based on the consultation.

Bond Revision

Revised reclamation cost increases are summarized on Table 3-5 of the permit.

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Project Title = TRAIL MOUNTAIN PARKING LOT EXTENSION
WATERSHED HYDROGRAPH

TABLE 7-2

Inflow into structure # 1
Structure type: Null

-- Watershed data for watershed # 1
Curve number = 98.0
Area = 0.1 acres
Hydraulic length = 120.00 Feet
Elevation change = 5.0 feet.
Concentration time = 0.01 hours
Concentration time type = SCS Upland Curves
Unit hydrograph type = Disturbed

-- Total Area = 0.1 acres

-- Storm data
Total precipitation = 2.4 inches
Storm type = SCS Type 1 storm, 24 hour storm
Peak Discharge = 0.05 cfs
Discharge volume = 0.02 acre ft

| time (hr.) | rainfall (in.) | hydrograph (cfs) | | time (hr.) | rainfall (in.) | hydrograph (cfs) |
|---|---|---|---|---|---|---|
| 0.00 | 0.000 | 0.000 | * | 0.10 | 0.004 | 0.000 |
| 0.20 | 0.004 | 0.000 | * | 0.30 | 0.004 | 0.000 |
| 0.40 | 0.004 | 0.000 | * | 0.50 | 0.004 | 0.000 |
| 0.60 | 0.004 | 0.000 | * | 0.70 | 0.004 | 0.000 |
| 0.80 | 0.004 | 0.000 | * | 0.90 | 0.004 | 0.000 |
| 1.00 | 0.004 | 0.000 | * | 1.10 | 0.004 | 0.000 |
| 1.20 | 0.004 | 0.000 | * | 1.30 | 0.004 | 0.000 |
| 1.40 | 0.004 | 0.000 | * | 1.50 | 0.004 | 0.000 |
| 1.60 | 0.005 | 0.000 | * | 1.70 | 0.005 | 0.001 |
| 1.80 | 0.005 | 0.001 | * | 1.90 | 0.005 | 0.001 |
| 2.00 | 0.005 | 0.001 | * | 2.10 | 0.005 | 0.001 |
| 2.20 | 0.005 | 0.001 | * | 2.30 | 0.005 | 0.001 |
| 2.40 | 0.005 | 0.001 | * | 2.50 | 0.005 | 0.001 |
| 2.60 | 0.005 | 0.001 | * | 2.70 | 0.005 | 0.001 |
| 2.80 | 0.005 | 0.001 | * | 2.90 | 0.005 | 0.001 |
| 3.00 | 0.005 | 0.001 | * | 3.10 | 0.005 | 0.001 |
| 3.20 | 0.005 | 0.001 | * | 3.30 | 0.005 | 0.001 |
| 3.40 | 0.005 | 0.002 | * | 3.50 | 0.005 | 0.002 |
| 3.60 | 0.005 | 0.002 | * | 3.70 | 0.005 | 0.002 |
| 3.80 | 0.005 | 0.002 | * | 3.90 | 0.005 | 0.002 |
| 4.00 | 0.005 | 0.002 | * | 4.10 | 0.006 | 0.002 |
| 4.20 | 0.006 | 0.002 | * | 4.30 | 0.006 | 0.002 |
| 4.40 | 0.006 | 0.002 | * | 4.50 | 0.006 | 0.002 |
| 4.60 | 0.006 | 0.002 | * | 4.70 | 0.006 | 0.002 |
| 4.80 | 0.006 | 0.002 | * | 4.90 | 0.006 | 0.002 |
| 5.00 | 0.006 | 0.002 | * | 5.10 | 0.006 | 0.002 |
| 5.20 | 0.006 | 0.002 | * | 5.30 | 0.006 | 0.002 |
| 5.40 | 0.006 | 0.002 | * | 5.50 | 0.006 | 0.002 |
| 5.60 | 0.006 | 0.003 | * | 5.70 | 0.006 | 0.003 |
| 5.80 | 0.006 | 0.003 | * | 5.90 | 0.006 | 0.003 |
| 6.00 | 0.006 | 0.003 | * | 6.10 | 0.007 | 0.003 |

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TABLE 7-2

| time (hr.) | rainfall (in.) | hydrograph (cfs) | | time (hr.) | rainfall (in.) | hydrograph (cfs) |
|---|---|---|---|---|---|---|
| 6.10 | 0.007 | 0.003 | | | | |
| 6.20 | 0.007 | 0.003 | * | 6.30 | 0.007 | 0.003 |
| 6.40 | 0.007 | 0.003 | * | 6.50 | 0.007 | 0.003 |
| 6.60 | 0.008 | 0.003 | * | 6.70 | 0.008 | 0.004 |
| 6.80 | 0.008 | 0.004 | * | 6.90 | 0.008 | 0.004 |
| 7.00 | 0.008 | 0.004 | * | 7.10 | 0.009 | 0.004 |
| 7.20 | 0.009 | 0.004 | * | 7.30 | 0.009 | 0.004 |
| 7.40 | 0.009 | 0.004 | * | 7.50 | 0.009 | 0.004 |
| 7.60 | 0.009 | 0.004 | * | 7.70 | 0.009 | 0.004 |
| 7.80 | 0.009 | 0.004 | * | 7.90 | 0.009 | 0.004 |
| 8.00 | 0.009 | 0.004 | * | 8.10 | 0.012 | 0.006 |
| 8.20 | 0.012 | 0.006 | * | 8.30 | 0.012 | 0.006 |
| 8.40 | 0.012 | 0.006 | * | 8.50 | 0.012 | 0.006 |
| 8.60 | 0.017 | 0.008 | * | 8.70 | 0.017 | 0.008 |
| 8.80 | 0.017 | 0.009 | * | 8.90 | 0.017 | 0.009 |
| 9.00 | 0.017 | 0.009 | * | 9.10 | 0.024 | 0.012 |
| 9.20 | 0.024 | 0.012 | * | 9.30 | 0.024 | 0.012 |
| 9.40 | 0.024 | 0.012 | * | 9.50 | 0.024 | 0.012 |
| 9.60 | 0.102 | 0.047 | * | 9.70 | 0.102 | 0.054 |
| 9.80 | 0.102 | 0.054 | * | 9.90 | 0.102 | 0.054 |
| 10.00 | 0.102 | 0.055 | * | 10.10 | 0.033 | 0.023 |
| 10.20 | 0.033 | 0.018 | * | 10.30 | 0.033 | 0.018 |
| 10.40 | 0.033 | 0.018 | * | 10.50 | 0.033 | 0.018 |
| 10.60 | 0.020 | 0.012 | * | 10.70 | 0.020 | 0.011 |
| 10.80 | 0.020 | 0.011 | * | 10.90 | 0.020 | 0.011 |
| 11.00 | 0.020 | 0.011 | * | 11.10 | 0.014 | 0.008 |
| 11.20 | 0.014 | 0.008 | * | 11.30 | 0.014 | 0.008 |
| 11.40 | 0.014 | 0.008 | * | 11.50 | 0.014 | 0.008 |
| 11.60 | 0.013 | 0.007 | * | 11.70 | 0.013 | 0.007 |
| 11.80 | 0.013 | 0.007 | * | 11.90 | 0.013 | 0.007 |
| 12.00 | 0.013 | 0.007 | * | 12.10 | 0.011 | 0.006 |
| 12.20 | 0.011 | 0.006 | * | 12.30 | 0.011 | 0.006 |
| 12.40 | 0.011 | 0.006 | * | 12.50 | 0.011 | 0.006 |
| 12.60 | 0.011 | 0.006 | * | 12.70 | 0.011 | 0.006 |
| 12.80 | 0.011 | 0.006 | * | 12.90 | 0.011 | 0.006 |
| 13.00 | 0.011 | 0.006 | * | 13.10 | 0.010 | 0.005 |
| 13.20 | 0.010 | 0.005 | * | 13.30 | 0.010 | 0.005 |
| 13.40 | 0.010 | 0.005 | * | 13.50 | 0.010 | 0.005 |
| 13.60 | 0.010 | 0.005 | * | 13.70 | 0.010 | 0.005 |
| 13.80 | 0.010 | 0.005 | * | 13.90 | 0.010 | 0.005 |
| 14.00 | 0.010 | 0.005 | * | 14.10 | 0.008 | 0.004 |
| 14.20 | 0.008 | 0.004 | * | 14.30 | 0.008 | 0.004 |
| 14.40 | 0.008 | 0.004 | * | 14.50 | 0.008 | 0.004 |
| 14.60 | 0.008 | 0.004 | * | 14.70 | 0.008 | 0.004 |
| 14.80 | 0.008 | 0.004 | * | 14.90 | 0.008 | 0.004 |
| 15.00 | 0.008 | 0.004 | * | 15.10 | 0.008 | 0.004 |
| 15.20 | 0.008 | 0.004 | * | 15.30 | 0.008 | 0.004 |
| 15.40 | 0.008 | 0.004 | * | 15.50 | 0.008 | 0.004 |
| 15.60 | 0.007 | 0.004 | * | 15.70 | 0.007 | 0.004 |
| 15.80 | 0.007 | 0.004 | * | 15.90 | 0.007 | 0.004 |
| 16.00 | 0.007 | 0.004 | * | 16.10 | 0.006 | 0.003 |
| 16.20 | 0.006 | 0.003 | * | 16.30 | 0.006 | 0.003 |
| 16.40 | 0.006 | 0.003 | * | 16.50 | 0.006 | 0.003 |
| 16.60 | 0.006 | 0.003 | * | 16.70 | 0.006 | 0.003 |
| 16.80 | 0.006 | 0.003 | * | 16.90 | 0.006 | 0.003 |
| 17.00 | 0.006 | 0.003 | * | 17.10 | 0.006 | 0.003 |

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TABLE 7-2

| time (hr.) | rainfall (in.) | hydrograph (cfs) | | time (hr.) | rainfall (in.) | hydrograph (cfs) |
|---|---|---|---|---|---|---|
| 17.30 | 0.006 | 0.003 | | | | |
| 17.40 | 0.006 | 0.003 | * | 17.50 | 0.006 | 0.003 |
| 17.60 | 0.006 | 0.003 | * | 17.70 | 0.006 | 0.003 |
| 17.80 | 0.006 | 0.003 | * | 17.90 | 0.006 | 0.003 |
| 18.00 | 0.006 | 0.003 | * | 18.10 | 0.006 | 0.003 |
| 18.20 | 0.006 | 0.003 | * | 18.30 | 0.006 | 0.003 |
| 18.40 | 0.006 | 0.003 | * | 18.50 | 0.006 | 0.003 |
| 18.60 | 0.006 | 0.003 | * | 18.70 | 0.006 | 0.003 |
| 18.80 | 0.006 | 0.003 | * | 18.90 | 0.006 | 0.003 |
| 19.00 | 0.006 | 0.003 | * | 19.10 | 0.006 | 0.003 |
| 19.20 | 0.006 | 0.003 | * | 19.30 | 0.006 | 0.003 |
| 19.40 | 0.006 | 0.003 | * | 19.50 | 0.006 | 0.003 |
| 19.60 | 0.006 | 0.003 | * | 19.70 | 0.006 | 0.003 |
| 19.80 | 0.006 | 0.003 | * | 19.90 | 0.006 | 0.003 |
| 20.00 | 0.006 | 0.003 | * | 20.10 | 0.005 | 0.003 |
| 20.20 | 0.005 | 0.003 | * | 20.30 | 0.005 | 0.003 |
| 20.40 | 0.005 | 0.003 | * | 20.50 | 0.005 | 0.003 |
| 20.60 | 0.005 | 0.003 | * | 20.70 | 0.005 | 0.003 |
| 20.80 | 0.005 | 0.003 | * | 20.90 | 0.005 | 0.003 |
| 21.00 | 0.005 | 0.003 | * | 21.10 | 0.005 | 0.003 |
| 21.20 | 0.005 | 0.003 | * | 21.30 | 0.005 | 0.003 |
| 21.40 | 0.005 | 0.003 | * | 21.50 | 0.005 | 0.003 |
| 21.60 | 0.005 | 0.003 | * | 21.70 | 0.005 | 0.003 |
| 21.80 | 0.005 | 0.003 | * | 21.90 | 0.005 | 0.003 |
| 22.00 | 0.005 | 0.003 | * | 22.10 | 0.005 | 0.003 |
| 22.20 | 0.005 | 0.003 | * | 22.30 | 0.005 | 0.003 |
| 22.40 | 0.005 | 0.003 | * | 22.50 | 0.005 | 0.003 |
| 22.60 | 0.004 | 0.002 | * | 22.70 | 0.004 | 0.002 |
| 22.80 | 0.004 | 0.002 | * | 22.90 | 0.004 | 0.002 |
| 23.00 | 0.004 | 0.002 | * | 23.10 | 0.004 | 0.002 |
| 23.20 | 0.004 | 0.002 | * | 23.30 | 0.004 | 0.002 |
| 23.40 | 0.004 | 0.002 | * | 23.50 | 0.004 | 0.002 |
| 23.60 | 0.003 | 0.002 | * | 23.70 | 0.003 | 0.002 |
| 23.80 | 0.003 | 0.002 | * | 23.90 | 0.003 | 0.002 |
| 24.00 | 0.003 | 0.002 | * | 24.10 | 0.000 | 0.000 |
| 24.20 | 0.000 | 0.000 | * | | | |

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Appendix 7-16

TABLE 7-3

VOLUME OF BACKFILL MATERIAL

| | AREA ($FT^2$) | X | FT | | $FT^3$ |
|---|---|---|---|---|---|
| 0+09 TO 0+24 | $\frac{0 + 264}{2}$ | | 15 | = | 1980 |
| 0+24 TO 0+47 | $\frac{264 + 349}{2}$ | | 23 | = | 7050 |
| 0+47 TO 0+64 | $\frac{349 + 585}{2}$ | | 17 | = | 7939 |
| 0+64 TO 0+77 | $\frac{585 + 323}{2}$ | | 13 | = | 5902 |
| 0+77 TO 0+87 | $\frac{323 + 0}{2}$ | | 10 | = | 1615 |
| | | | | TOTAL | 24,486 |

= 907 $YD^3$

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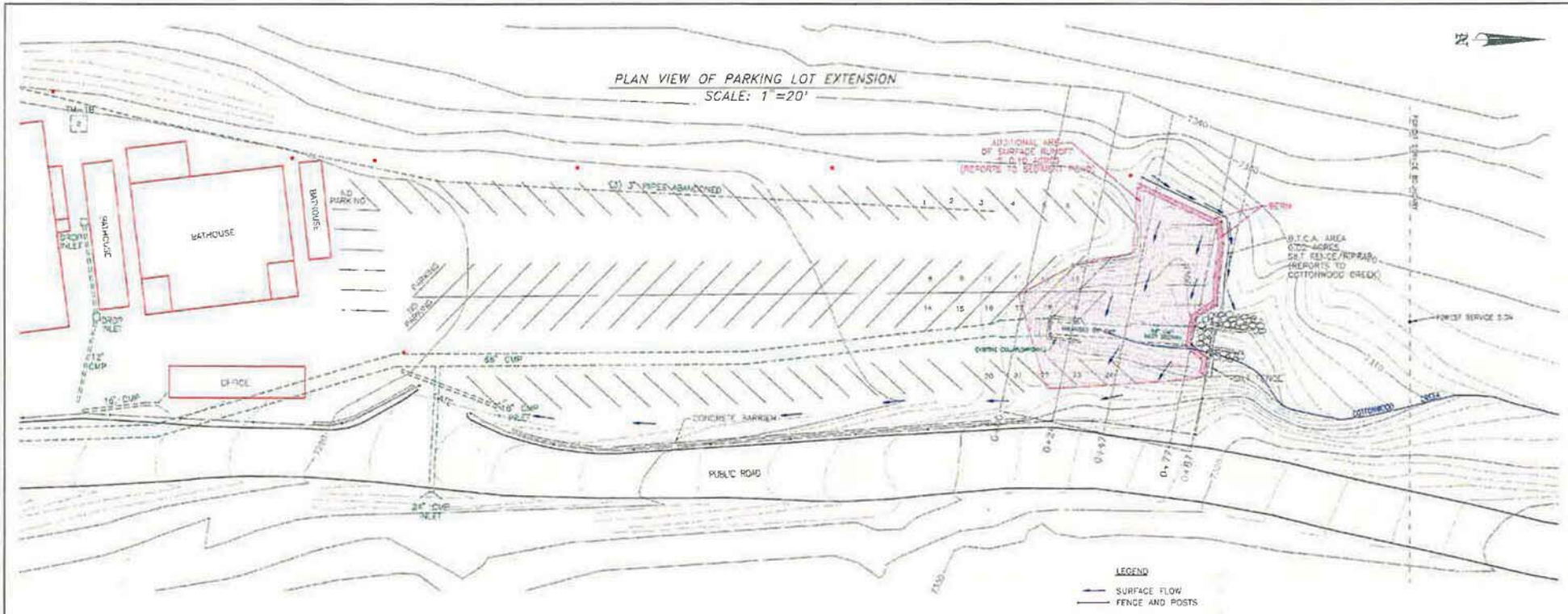
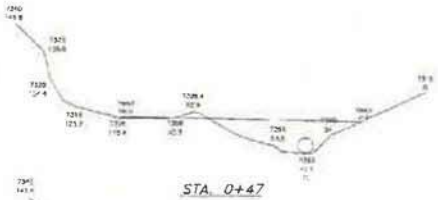
## PLAN VIEW OF PARKING LOT EXTENSION
SCALE: 1"=20'

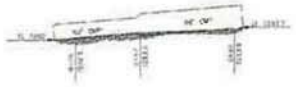



## PARKING LOT EXTENSION CROSS SECTIONS
SCALE: 1"=20'

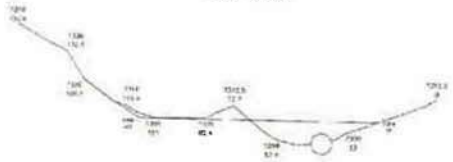
STA. 0+00



STA. 0+47



PROFILE OF CMP



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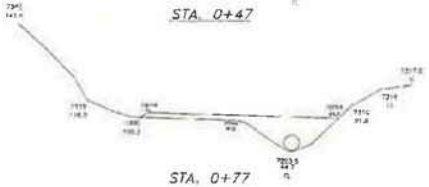

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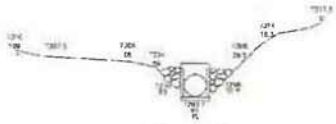

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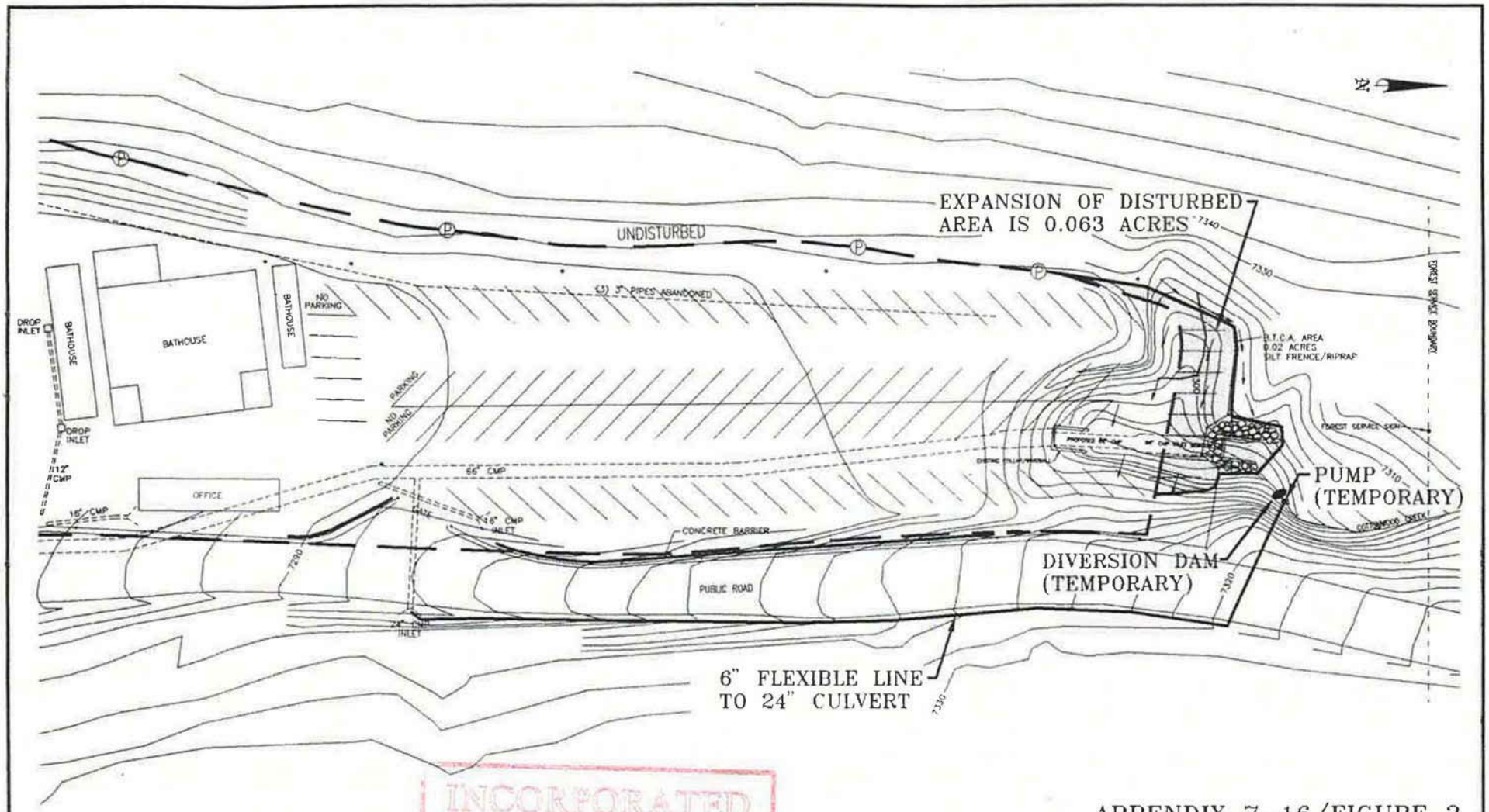
APPENDIX 7-16 FIGURE 1

| | |
|---|---|
| ENERGY WEST MINING COMPANY | |
| TRAIL MOUNTAIN MINE PARKING LOT EXTENSION PLAN VIEW AND CROSS SECTIONS | |
| DRAWN BY: K.J.L. & J.C. | TMS1599D |
| SCALE: 1"=20' | DRAWING #: |
| DATE: JULY 13, 1994 | SHT. 1 OF 1 |

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PRICE FIELD OFFICE
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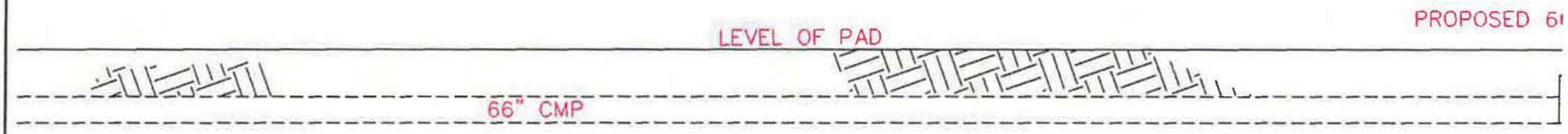
APPENDIX 7-16/FIGURE 2

CAD FILE NAME/DISK#: TMS1605A

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

*TRAIL MOUNTAIN MINE*
*PROPOSED CULVERT EXTENSION*
*APPENDIX 7-16/FIGURE 2*

| | | | |
|---|---|---|---|
| DRAWN BY: | K. LARSEN | *TMS1605A* | |
| SCALE: | 1" = 60' | DRAWING #: | |
| DATE: | JULY 13, 1996 | SHEET 1 OF | REV. |

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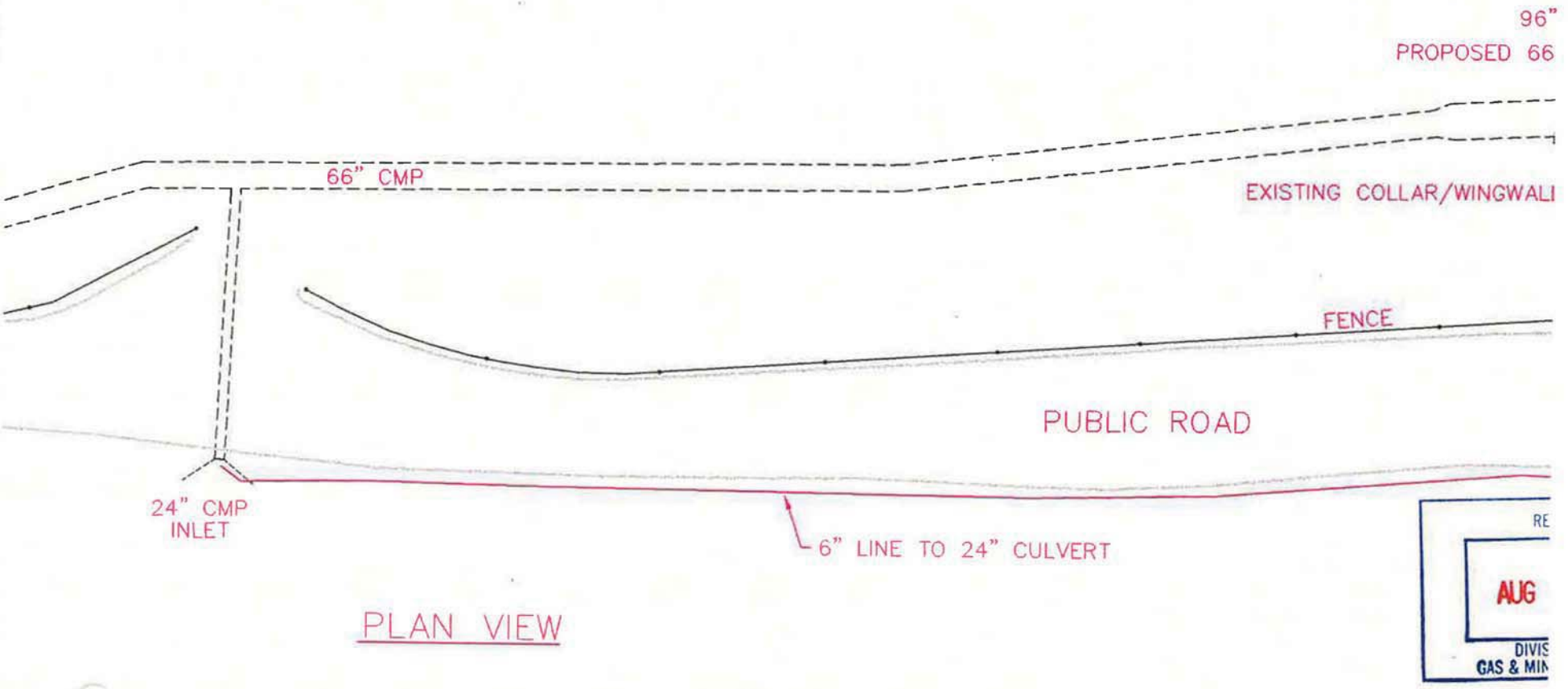


PLAN VIEW




NOTE:
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APPENDIX 7-17

COTTONWOOD CANYON CREEK HYDROGEOLOGIC INVESTIGATION 1992/2000

# Appendix 7-17

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# COTTONWOOD CANYON CREEK
# 1992 HYDROGEOLOGIC INVESTIGATION
## REVISED IN 2000

The following document is a complete history of the Cottonwood Spring citizen complaint and resultant hydrogeologic study. The study confirmed that groundwater resources of Cottonwood Canyon area respond directly to precipitation and have not been influenced by mining in the Deer Creek Mine. PacifiCorp has gone to great lengths and expense to satisfy the concerns of the water users and regulatory agencies involved in Cottonwood Canyon.

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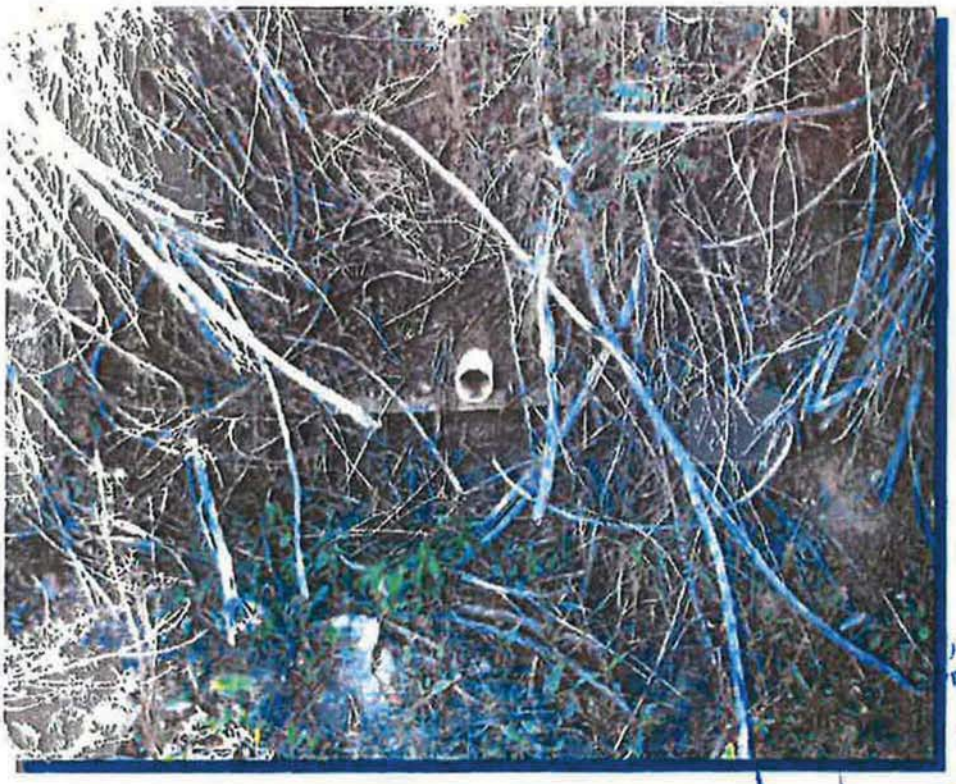
*HISTORY OF CITIZEN COMPLAINT: COTTONWOOD SPRING*

On July 31, 1991 a citizen complaint claiming that the mining in the Deer Creek Mine dried up a spring known as Cottonwood Spring (designated on map HM-1 and HM-12 as TM-23 [Section 14, Township 17 South, Range 6 East], Volume 9) was filed by Jim Peacock. According to Mr. Peacock, Cottonwood Spring produced approximately one to three cubic feet/second and was the main source of flow for Cottonwood Canyon Creek (conversation during an on site visit with Utah State Division of Water Rights, Cottonwood Irrigation Company, United States Forest Service, Utah State Division of Oil, Gas & Mining [DOGM], and PacifiCorp held on August 1, 1991). Mr. Peacock indicated that production from the spring had been decreasing over the past several years and that he was no longer able to irrigate approximately twenty-two acres located on the north side of Highway 31 at the junction of Cottonwood Canyon Creek and Straight Canyon. Discussions during the on site visit centered around: location and extent of mining in the Deer Creek Mine, mine water discharge trends, timing of the Roans Canyon fault crossing (3rd North), intersection of sympathetic faulting in 1st and 2nd Right off of 4th South, the drought which has had a major impact on the hydrologic resources of the area, and the hydrogeology of Cottonwood Spring.

***COTTONWOOD SPRING***



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As a result of the on site visit, DOGM reviewed the available historical data on the flow and quality of Cottonwood Spring (see Attachment 1). In addition to historical review, DOGM requested that PacifiCorp update the Probable Hydrologic Consequences (PHC) section of the Deer Creek Mine Permit Application Package (PAP). The Volume 9 - Hydrologic Section: PHC was updated and submitted on three separate occasions: December 19, 1991; March 23, 1992; and again on July 15, 1992. As part of the March 23, 1992 submittal PacifiCorp committed to drilling a series of wells and conducting a resistivity survey in Cottonwood Canyon Creek during the 1992 field season to determine the hydrologic significance of the alluvial deposits and their interrelationships with the surrounding strata. In addition to the work completed in 1992, PacifiCorp contracted Mayo & Associates during 1996 to complete a comprehensive hydrologic investigation of surface and groundwater systems in the East & Trail Mountain areas (refer to Mayo & Associates Study in Volume 9: Hydrologic Support Information). During the investigation, Mayo & Associates analyzed: 1) solute and isotopic compositions of surface waters and groundwaters, 2) surface water and groundwater discharge data, 3) piezometric data, and 4) geologic information.

This report will summarize the findings of PacifiCorp's and Mayo & Associates hydrogeologic investigation of Cottonwood Canyon Creek/Cottonwood Spring and will include a discussion on the following topics:

1. Introduction/General Description
   - Cottonwood Canyon Drainage
   - Cottonwood Spring
     - Relationship to the Deer Creek Mine
     - Water Rights Information
2. Spring and Seep Survey
   - Cottonwood Spring (TM-23) Data
     - Historical Flow Data
     - United States Geological Survey Data
     - Mine Reclamation Plan Data Collection (Trail Mountain Mine)
     - Cottonwood Spring Source Development
     - Cottonwood Canyon Gain/Loss Surveys
3. Geology
   a. Stratigraphy
   b. Structure
   c. Geomorphology - Glaciation
4. Resistivity Survey Results
5. Drilling Results
6. Aquifer Test Results
7. Data from Mayo & Associates Study
8. DOGM Findings
9. Summary

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# 1. INTRODUCTION/GENERAL DESCRIPTION

Cottonwood Canyon Drainage

Cottonwood Canyon Creek is a major drainage system which borders the western limit of the East Mountain Federal Coal Leases (see HM-1, Volume 9 of the PAP). Based on data collected by PacifiCorp, Cottonwood Canyon Creek is an ephemeral stream from its headwaters to the northeast quarter of Section 24, Township 17 South, Range 6 East and intermittent from that point to its confluence with Cottonwood Creek at Straight Canyon. During periods of drought, flow in Cottonwood Canyon Creek is limited to flow emanating from the alluvial deposits at the intersection with Roans Canyon. From the intersection with Roans Canyon to Section 36 the stream loses water to the alluvial deposits. The drainage is dry from Section 36 to Section 6 except during spring runoff which normally occurs from late April through June or during precipitation events. Flow in the channel reemerges in Section 6 and continues to the confluence with Cottonwood Canyon at Straight Canyon.

The USGS installed a Parshall flume in Section 31, Township 17 South, Range 7 East and collected flow data daily from October 1977 through September 1979. PacifiCorp began collecting monthly flow information at the USGS flume in 1979. This information has been submitted in the Annual Hydrologic Reports and documents the trends indicated by the USGS. Distribution patterns of stream flow are characteristic of watersheds in the western highlands where the majority of the annual water yield occurs in the spring and early summer as a result of snowmelt runoff. Peak runoff, typically occurring in May/June, averages approximately four (4) cubic feet second (cfs), with base flows averaging less than one half (0.5) cfs (see Attachment 2 and the following figure).

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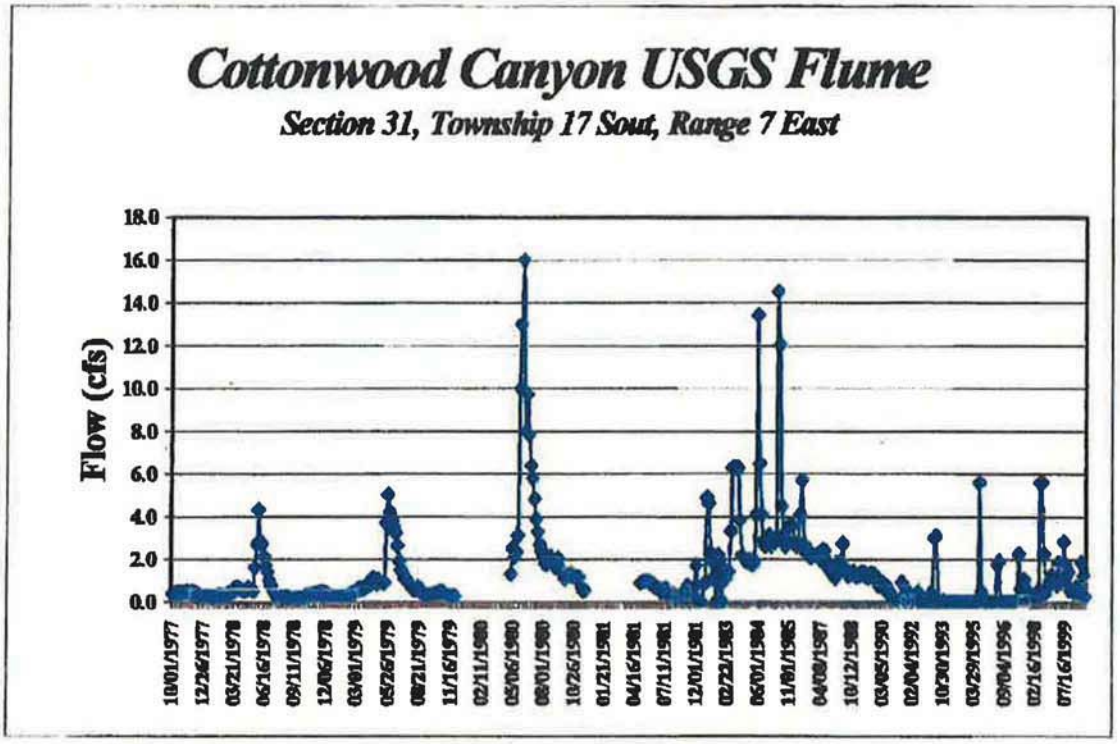


Cottonwood Spring

Cottonwood Spring is located in the southeast quarter of Section 14, Township 17 South, Range 6 East. A small access road leads from the main road (Forest Service Development Road 040) to the drainage bottom. Cottonwood Spring is situated on the east side of Cottonwood Canyon Creek approximately two (2) feet above the drainage bottom (site development and flow data will be discussed in the following section).

*Relationship to the Deer Creek Mine:*

Cottonwood Spring is located west of Federal Coal Lease U-083066 (limit of PacifiCorp's Federal Coal Leases). At the time the citizen compliant was filed (1991), the nearest mining was approximately two (2) miles to the east, as shown in the following figure:

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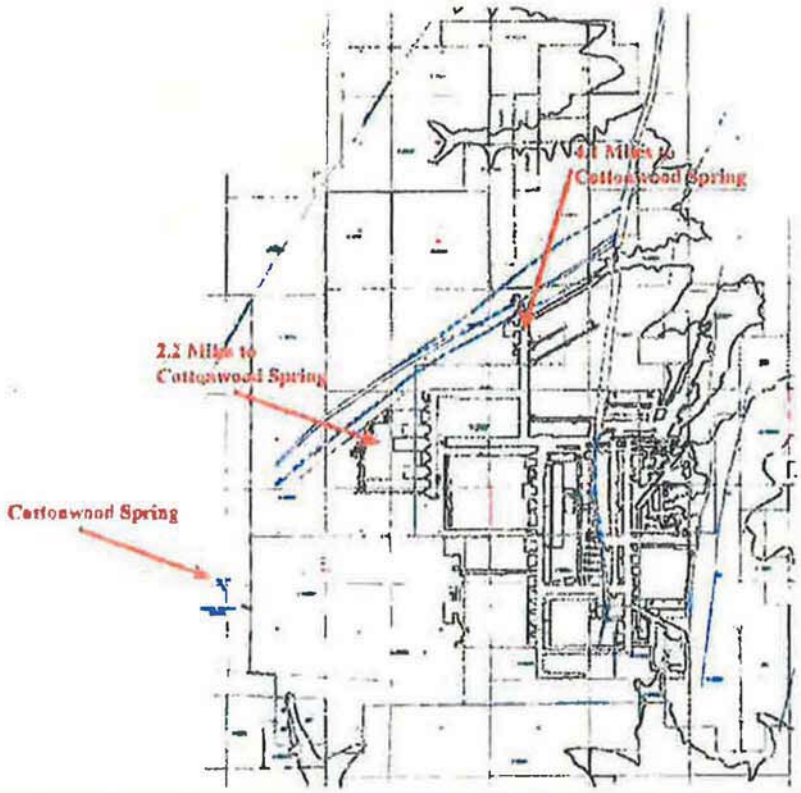


**Deer Creek Mine Map**
**1991**

During the site visit on August 1, 1991, questions were raised concerning the proximity of mining in the Deer Creek Mine (in particular, the Roans Canyon Fault crossing and the area of current longwall mining – 4th South area). As shown on the figure, the Roans Canyon Fault crossing is approximately 4.1 miles east of Cottonwood Spring and 4th South area is approximately 2.2 miles east of Cottonwood Spring.

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*Water Rights Information:*

As documented during the site visit, the U.S. Forest Service held the water rights/point of diversion for Cottonwood Spring, Water Right # 93-701, quantity 0.0110 cfs. The following figure was reproduced from the Utah Division of Water Rights database:

UTAH DIVISION OF WATER RIGHTS
WRPLAT POINT OF DIVERSION LOCATION PROGRAM

| MAP CHAR | WATER RIGHT | QUANTITY CFS | AMD/YR | AC-FT | SOURCE DESCRIPTION or WELL INFO DIAMETER | DEPTH | YEAR LOG | MONTH | POINT OF DIVERSION DESCRIPTION EAST | CNR | SEC | TWN | RNG | B&M | UAPTSUPR NPEEUGTE NPRERUPD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 93 701 | .0110 | | | .00 Cottonwood Spring | | | | | | | | | | X X X |
| | WATER USE(S): STOCKWATERING | | | | | | | | PRIORITY DATE: 00/00/1875 | | | | | | |
| | USA Forest Service | | | | 324 25th Street | | | | Ogden | | | | | UT 84401 | |
| 1 | 93 229 | .0000 | | | .00 Trail Canyon Creek | | | | | | | | | | X X X |
| | WATER USE(S): STOCKWATERING | | | | | | | | PRIORITY DATE: 00/00/1875 | | | | | | |
| | USA Forest Service | | | | 324 25th Street | | | | Ogden | | | | | UT 84401 | |

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## 2. SPRING AND SEEP SURVEY

PacifiCorp conducted a spring and seep survey during the summer of 1991 from north of the Trail Mountain Mine to north of Winks Canyon. This information, along with the East Mountain spring and seep surveys, was compiled to develop a comprehensive spring and seep map for the Cottonwood Canyon area (refer to HM-4). The spring surveys identified several sources along the down dip side of Cottonwood Canyon (East side). Two of the springs identified were included in the East Mountain Spring Monitoring Program in 1991 (springs 91-72 and 91-73). The contribution of groundwater from the upper portion of the Blackhawk Formation on the east side of Cottonwood Canyon was also documented in resistivity surveys (refer to Section 4: Resistivity Results). During the spring inventory, individual drainages were inspected and classified based on flow characteristics. Based on the field investigation conducted in the summer of 1991, all of the streams emanating from the Cottonwood Canyon Creek area would be classified as ephemeral except Cottonwood Canyon Creek, which would be classified as intermittent as discussed previously.

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**Cottonwood Spring (TM-23) Data:**

*Historical Flow Data:*

The United States Geological Survey (USGS) collected quality and quantity data at the Cottonwood Spring site as part of comprehensive hydrologic study of the central Utah Coal Field from 1978 through 1982 (Open File Reports 81-539 and 84-067). Monitoring of Cottonwood Spring was included in the Trail Mountain MRP in 1986 following a spring and seep survey conducted by JBR in 1985. The following is a list of sources and the time frame in which data was collected:

| | |
|---|---|
| USGS | 1978 - 1982 |
| JBR | 1985 - Spring Survey |
| Trail Mountain Coal Co. | 1986 - 1987 |
| Mountain Coal Co. | 1987 - 1992 |
| Energy West Mining | 1992 – Present |

Flow prior to the drought in the mid to late 1980's averaged approximately 60 GPM. Post drought flows diminished rapidly (refer to the following hydrograph comparing Cottonwood Spring flow to the regional Palmer Drought Index).

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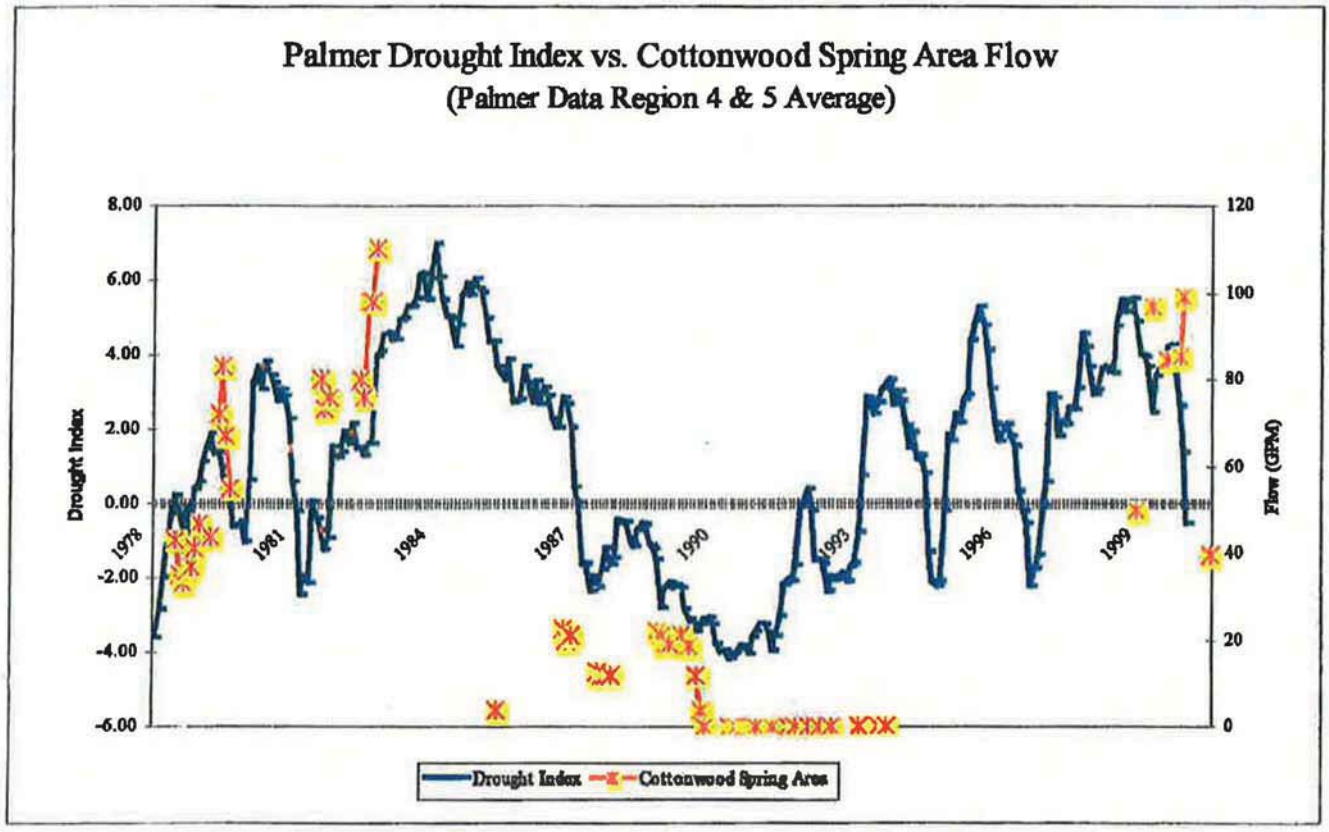


*United States Geological Survey Flow Data:*

As referenced above, the USGS conducted a comprehensive hydrologic investigation of the Central Utah Coal Field in the late 70's and early 80's. Cottonwood Canyon drainage system was included within study. Flow from Cottonwood Spring was reported in Open File Reports 81-539 and 84-067 ranging from 33 to 110 gallons per minute. Methods of data collection were not reported. During PacifiCorps investigation, concerns were expressed at several meetings with the regulatory agencies on the method of data collection (gain/loss vs. pipe measurement). Reviewing Open File Report 81-539, it is apparent that the method utilized to document flow from Cottonwood Spring was to conduct gain/loss measurements along Cottonwood Creek above and below the alluvial discharge area (method of measurement confirmed by Jim Kohler, BLM Geologist, personal conversation with USGS field assistant involved in the hydrologic investigation). The following figure includes pages reproduced from Open File Report 81-539, documenting spring flow and gain/loss measurements.

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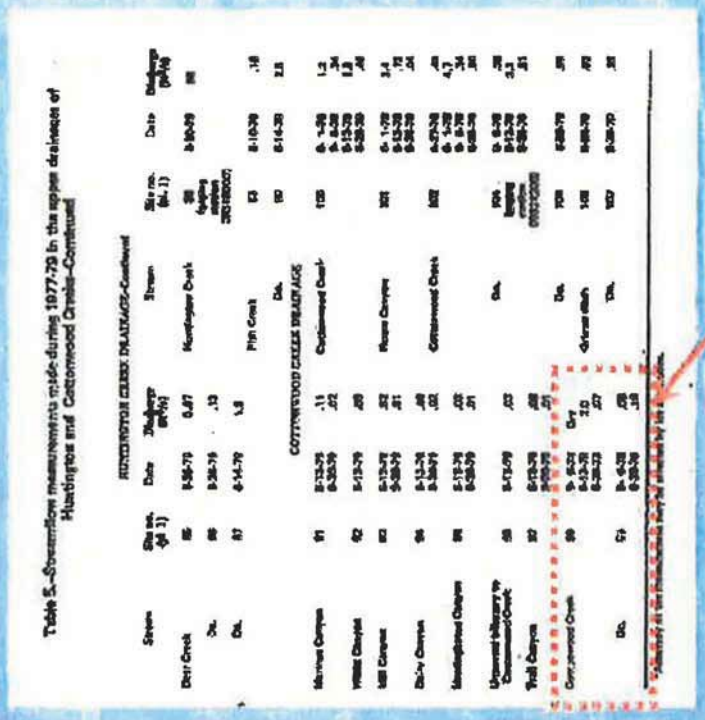
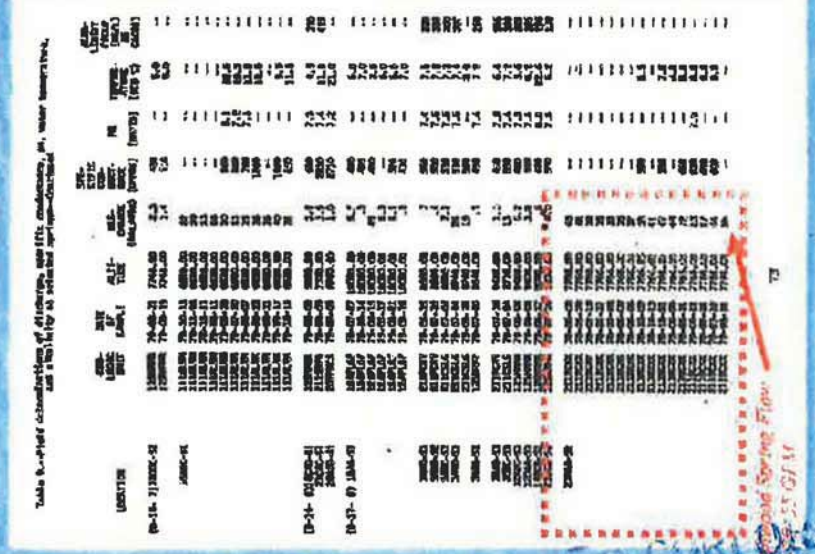
# Cottonwood Canyon Spring

## U.S.G.S. Report 81-539





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*Mine Reclamation Plan Data Collection (Trail Mountain Mine):*

Data collected by Trail Mountain Mine during 1985-1992 revealed that flow from Cottonwood Spring varied from 0 to approximately 22 gpm (pipe flow collected)

| | | |
|---|---|---|
| JBR | | 1985 - Spring Survey |
| Trail Mountain Coal Co. | 1986 - 1987 | |
| Mountain Coal Co. | 1987 - 1992 | |

| Date | Flow (gpm) | Comments |
|---|---|---|
| 10/28/85 | 4.0 | |
| 9/30/86 | 22.5 | |
| 10/20/86 | 20.0 | |
| 11/11/86 | 20.8 | |
| 6/30/87 | 12.6 | |
| 7/15/87 | 12.0 | |
| 8/31/87 | 12.0 | |
| 9/25/87 | 12.0 | |
| 6/30/88 | 0.0 | |
| 9/20/88 | 22.0 | |
| 10/31/88 | 21.0 | |
| 11/29/88 | 19.0 | |
| 12/7/88 | 19.2 | |
| 3/13/89 | 21.5 | |
| 5/25/89 | 18.5 | |
| 7/19/89 | 12.0 | Pipe all but dry, approx. 12 seeping up at base of channel |
| 8/25/89 | 4.0 | Pipe not flowing, measured at base of channel |
| 9/17/89 | 0.0 | |
| 1989-92 | 0.0 | |

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During meetings with the regulatory agencies, questions were raised concerning the supposed coincidence of the timing of the Roans Canyon fault crossing and the reduction in flow of Cottonwood Spring (refer to Attachment 5 for Cottonwood Spring field data sheets). The extensive hydrogeologic data and Cottonwood Spring flow data collected by the previous operator reveals that Cottonwood Spring reduced to zero flow one year prior to the rock slope development. Another interesting factor is, as the flow from the decreased, the source of Cottonwood Spring moved to the base of the channel.

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*Cottonwood Spring Source Development*

Site development during the initial review (1991) included a three (3) inch section of PVC pipe with a small board supporting the discharge (see adjoining photo). As documented earlier, USGS utilized gain/loss measurements to collect groundwater production data from the Cottonwood Spring area. Measurements collected as part of the hydrologic monitoring programs of the previous coal companies, were discharge rates from the PVC pipe, except when the flow diminished in July of 1989 and discharge from the base of the channel was included. Based on review of the data, it is unclear when the PVC pipe was installed.

As part of the Cottonwood Spring investigation, PacifiCorp excavated the site (only hand shovel required) to verify the development construction. A three (3) inch PVC pipe, approximately three [3] feet in length, was simply inserted into coarse gravel lens with soil compacted around the pipe (see adjoining photo). The gravel lens is approximately two (2) feet thick and is heavily oxidized indicating near surface influence.

Alluvial/glaciated deposits of Cottonwood Canyon consist of stratified layers ranging from silt to coarse gravels (refer to the Geomorphology Section for a complete discussion on Cottonwood Canyon). Stratification was documented in the development of the Cottonwood Canyon monitoring wells and can be seen in the eroded bank deposits near Cottonwood Spring (see adjoining photo). The very fine sediments (very low transitivity) effectively impedes vertical groundwater migration.

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*Cottonwood Canyon Gain/Loss Surveys*

Energy West Mining Company initiated gain/loss surveys in 1998 of Cottonwood Canyon to verify/compare:

- Surface/groundwater relationships
- Hydrologic trends of the Cottonwood Canyon monitoring wells
- Cottonwood Spring discharge rates
- Compare recent data Cottonwood Spring flow data to USGS study

Gain/loss surveys included measurements collected along the Cottonwood drainage from Mill Canyon in Section 2, Township 17 South, Range 6 East to below Roans Canyon in Section 24, Township 17 South, Range 6 East (refer to Attachment 4). The survey included measurements of each of the contributing sub-drainages and Spring 91-72. Depending upon flow, quantity data was collected at each site utilizing either the bucket/stop watch method or by temporarily installing a 90° v-notch weir.

Energy West closely monitors the groundwater levels in a series of monitoring wells in Cottonwood Canyon as well as climatic trends of central Utah (refer to Drilling Results Section for more detail). As climatic trends returned to normal patterns, (refer to Palmer Drought Index figure presented earlier), the alluvial system of Cottonwood Canyon started to recharge. This is evident by the upward trends in the alluvial monitoring wells (refer to Drilling Results Section, Drill Site #1). As the trend line of the water elevation of well CCCW-1A equaled the elevation of the Cottonwood Spring area, discharge from the alluvial deposits was re-established. From the data collected over a two year period (1998 – 2000), discharge from Cottonwood Spring area ranged from approximately 40 to 99 GPM (refer to Attachment 4 for Gain/Loss data).

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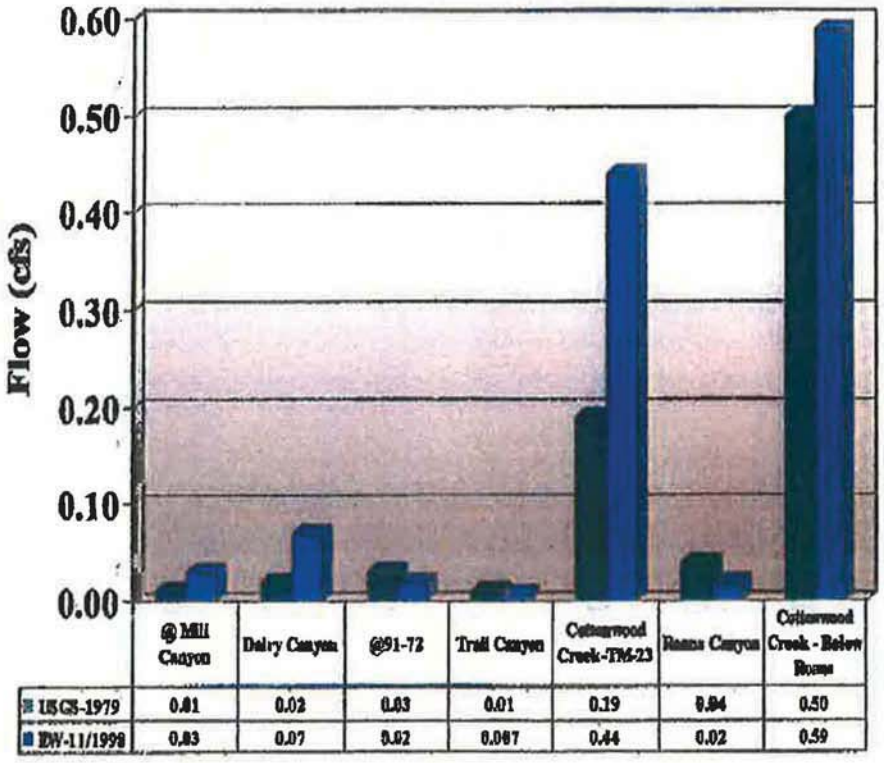
The following figure illustrates the data collected by Energy West in November 1998 compared directly to the data collected by the USGS in 1979.

## Cottonwood Canyon Creek

### Flow Data Comparison

### USGS August 1979* Energy West November 1998




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM5-23 | Rams Canyon | Cottonwood Creek - Below Rams |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | 0.04 | 0.50 |
| EW-11/1998 | 0.03 | 0.07 | 0.02 | 0.007 | 0.44 | 0.02 | 0.59 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 57.8 GPM/0.13 CFS

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# 3. GEOLOGY

a. STRATIGRAPHY

The rock formations exposed in the Cottonwood Canyon Creek area range from Upper Cretaceous to Tertiary in age (refer to HM-12). The formations, in ascending order:

Masuk Shale:

Age: Cretaceous EST. Thickness: +1000'

Uppermost member of the Mancos Shale; consists of light- to medium-gray marine mudstones; weathers readily, forming slopes which are often covered with debris. This formation interfingers with the Starpoint Sandstone. Exposure is limited to the area south of the Trail Mountain Mine.

Star Point Sandstone:

Age: Cretaceous EST. Thickness: 400'

Consists of three distinct sandstone tongues separated by Masuk Shale. The lower and upper members are cliff forming, massive, gray, fine to medium grained sandstone units.

Blackhawk Formation:

Age: Cretaceous EST. Thickness: 750'

Consists of alternating mudstones, siltstones, sandstones, and coal. Although coal is generally found throughout the formation, the only minable seam exposed in Cottonwood Canyon Creek is the Hiawatha Seam located directly above the Starpoint Sandstone. Outcrops of the Blackhawk Formation occur throughout the length of Cottonwood Canyon Creek from the Trail Mountain Mine to Flat Canyon.

Castlegate Sandstone:

Age: Cretaceous EST. Thickness: 250'

Forms an escarpment which surrounds Cottonwood Canyon Creek. Consists of coarse-grained, light gray, fluvial sandstones; pebble conglomerates; and zones of mudstone.

Price River Formation:

Age: Cretaceous EST. Thickness: 350'

Consists mainly of fine-medium grained sandstones with subordinate amounts of mudstone and conglomerates. Forms slopes and ledges above the Castlegate Sandstone.

North Horn Formation:

Age: Cretaceous/Tertiary EST. Thickness: 850'

Mudstones dominate the rock types present and vary in color from gray, red, yellow, green to red. Localized, lenticular sandstone channels are present throughout the formation.

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Flagstaff Limestone:

Age: Tertiary/Paleocene EST. Thickness: 100'

The Flagstaff Limestone is a light gray to tan fossiliferous lacustrine limestone. The Flagstaff forms the "Cap, " or mesa – like table top to North Horn, Trail, and East Mountains.

Alluvial Deposits:

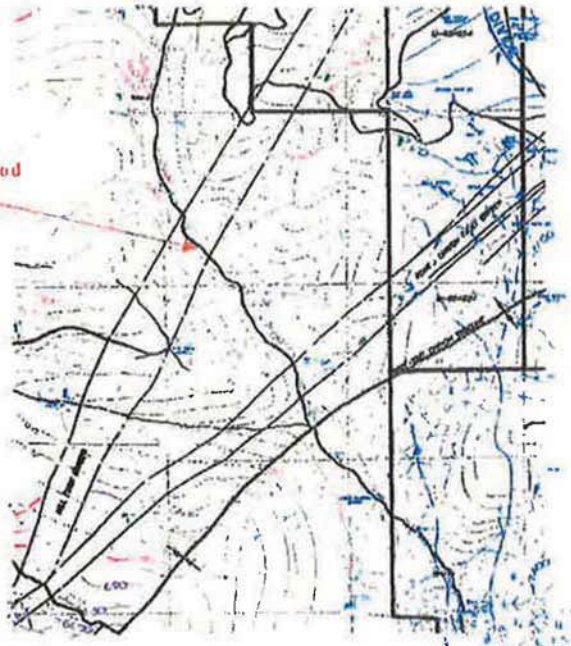
Age: Pleistocene EST. Thickness: Variable

Consists of sandstone boulders, sand, silt, and clay. Glacial deposits and lateral/terminal moraines occur above the intersection of Roans Canyon. Below, the canyon is characterized by non-glaciated valley fill deposits.

b. STRUCTURE

Two main structural features occur within the Cottonwood Canyon Creek area, the Straight Canyon Syncline and northeast-southwest trending fault-fracture systems. The Straight Canyon Syncline is a north-northeast trending syncline (refer to the Geologic Section of the PAP). In the area south of the syncline the strata dips gently in a northwest direction toward the syncline at approximately one to three degrees. Northwest of the syncline axis the strata dip to the southwest at approximately three to five degrees.

**Cottonwood Canyon Geology Map**

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The second structural feature consists of northeast-southwest trending fault systems known as the Roans Canyon and Mill Fork Canyon grabens. The Roans Canyon graben bisects the northern reserves of the East Mountain Federal Coal Leases and occurs parallel to the axis of the Straight Canyon Syncline (see HM-1 and HM-12, Volume 9 of the PAP). The system contained up to six normal faults with displacements ranging from a few feet to over 150 feet in the 3rd North fault crossing (see the following figure).

***DEER CREEK MINE***
***3rd NORTH ROANS CANYON FAULT CROSSING***

PacifiCorp has conducted extensive studies to document the hydrologic significance of the graben structure (see Volume 9, R645-301-711, A. Existing Groundwater Resources: Structural Hydrologic Features). Based on research conducted by PacifiCorp, faulting along the Roans Canyon system occurred during two phases. During the first (east-west compression phase), strike slip movement occurred prior to the deposition of the Flagstaff Limestone; during the second (east-west tension phase), normal faulting occurred along a strike slip faulting plane, resulting in the formation of a graben structure. Displacement along the Roans Canyon Fault system increases to the north until it is terminated by the Pleasant Valley Fault system. In the area of Cottonwood Canyon Creek the Roans Canyon Fault system consists of two or more fractures with little or no displacement (see Cottonwood Geology Map on previous page).

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During the resistivity study a second linear feature, which could possibly be a southern extension of the Mill Fork Canyon fault system, was detected on transect line CCCR-5 (refer to Cottonwood Canyon Resistivity Study - Volume 9 Hydrologic Support Information). The southernmost fault of the Mill Fork Canyon Graben was intersected in Arco's Beaver Creek #4 Mine in Mill Fork Canyon and has a displacement of about twenty (20) feet down on the northwest side. Where the fault crosses the northern end of East Mountain, the fault has a displacement of about thirty (30) feet down on the northwest side (see HM-7 in Volume 9 of the PAP).

## c. Geomorphology: Glaciation

Cottonwood Canyon is a major drainage system where evidence of glaciation exists. Since mountain glaciers are surrounded by areas of exposed rock that are constantly subject to erosion, they collect a great deal of rock waste that is carried by the ice toward the terminus of the glacier. This debris, referred to as a moraine, is supplied by the mechanically weathered material which falls from the walls of the valley and by rock abraded from the bed and is classified with reference to its position as ground, lateral, or terminal moraine deposits. All material deposited beneath the advancing ice, together with that deposited from the base as an irregular sheet during melting, constitutes the ground moraine. At the terminus of the glacier, where the amount of ice waste due to melting equals the advance due to glacial movement, debris is dropped as a terminal moraine. The debris that accumulates on the borders of a valley glacier forms the lateral moraines of the moving ice-stream. When the glacier melts, the lateral moraines are left as ridges, or terrace-like structures, bordering the steep-sided mountain valleys[1].

From the headwaters to Section 24, Township 17 South, Range 6 East the canyon is characterized by U-shaped valleys with associated lateral and terminal moraine deposits, (topographic landscape modification in Cottonwood Canyon due to Pleistocene glaciation has been documented by the Utah Geological and Mineral Survey [U.G.M.S.], Bulletin No. 112, page 7).

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[1] Emmons, W.H.; Thiel, G.A.; Stauffer, C.R.; Allison, I.S., 1955, Geology: Principles and Process, pp. 241-244

*Utah Geological and Mineral Survey [U.G.M.S.], Bulletin No. 112, page 7*

Limestone, dense, light gray, thin-bedded, fossiliferous ..... 25.2
Covered slope ..... 79.4

Total Flagstaff Limestone ..... 104.6

North Horn Formation

The stratigraphic relationships of the units just described are shown diagrammatically in figure 6. For stratigraphic work relating to coal, the two key horizons in the field are the top of the Star Point and the top of the Castlegate.

Quaternary Deposits

Unconsolidated Quaternary deposits consist of alluvium (stream channel and valley fill deposits), regolith, glacial drift, moraines (figure 7), and colluvium (including talus) on slopes and at the base of slopes and cliffs. These deposits consist of mixed proportions of clay, silt, sand, and gravel with boulders.

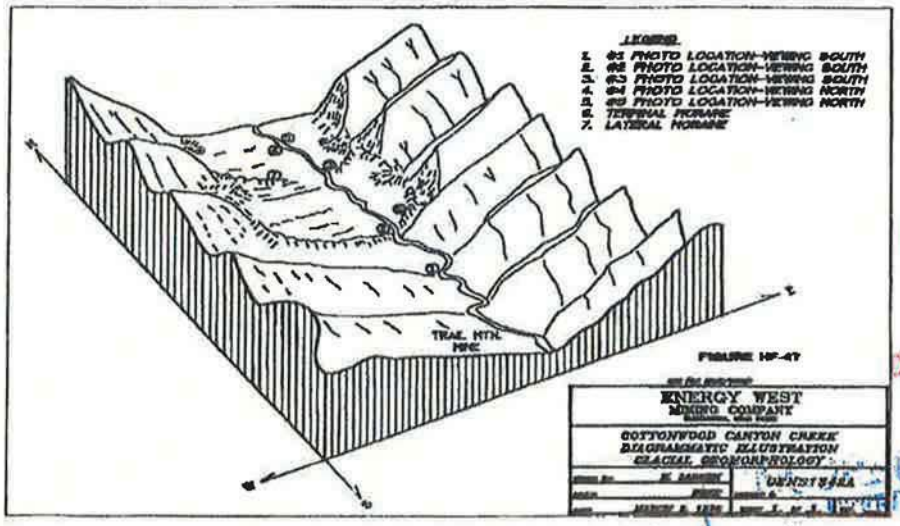
Some examples of alluvial thicknesses are: (1) drill hole 3 in Cottonwood Canyon, 120 feet; (2) drill hole 4 in Cottonwood Canyon, 60 feet; (3) drill hole 5

Structure

Tectonically, the Wasatch Plateau is in a transition zone between the relatively stable Colorado Plateau on the east side and the relatively complex and unstable Basin and Range province on the west side. On the west side the strata of the plateau dip into a

Figure 7. A view to the north of upper Cottonwood Canyon. The topography has been modified by Pleistocene glaciation.

Lateral moraine deposits most commonly occur at intersections with side canyons. Terminal moraine deposits occur at the northwest corner of Section 24, and from this point to near the confluence with Straight Canyon the canyon can be characterized as a V-shaped valley with little evidence of glaciation. A series of photos and diagrammatic illustrations of Cottonwood Canyon Creek depict the mountain glacial features discussed above (see Volume 9, photo section and Figure HF-47).

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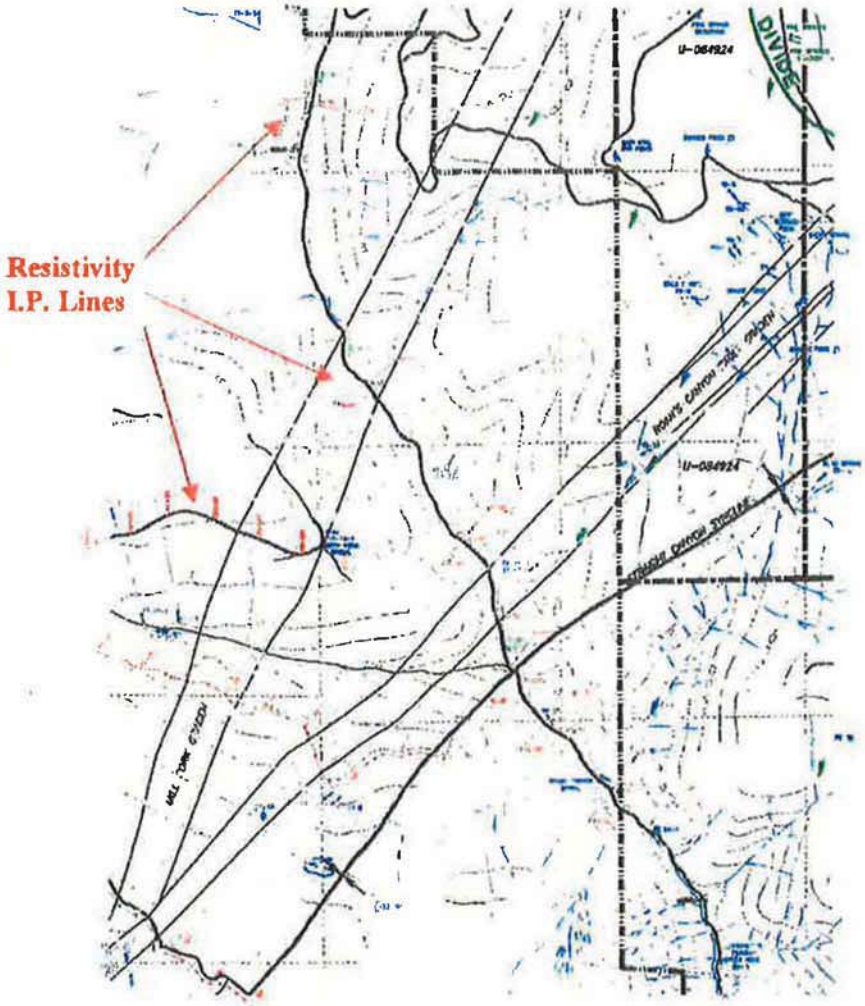
*Cottonwood Canyon Glacial Geomorphology*

## 4. RESISTIVITY RESULTS

PacifiCorp/Energy West Mining Company contracted Geowestern to conduct a Resistivity-Induced Polarization (I.P.) Survey in Cottonwood Canyon Creek in the summer 1992.

***Location of Resistivity Surveys***

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The intent of the survey was to identify fractures/faults and estimate the depth and the extent of alluvium in Cottonwood Canyon Creek by contrasting areas of Resistivity and I.P. response (see Volume 9, Hydrologic Support Information - Results of a Resistivity-Induced Polarization

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Survey, Rilda and Cottonwood Canyons: East Mountain Property). Profiling in Cottonwood Canyon Creek included six lines perpendicular to the canyon generally extending to outcrops of the Blackhawk Formation and one parallel to the canyon bottom. Based upon the results of the resistivity and induced polarization surveys it is apparent that the depth of the alluvium is relatively consistent throughout the length of the canyon surveyed but the lateral extent of the deposits increases from north to south to a point just north of CCCR-2 (refer to HM-7). The pseudosections indicate that the fractures/faults cutting the lower end of the Cottonwood Canyon impound water in the alluvium approximately 300-500 feet up-canyon from the fracture/fault. The pseudosections also indicate that the level of groundwater increases in the area of Cottonwood Spring due to the change in the volume of the alluvium caused by change in geomorphology (glaciated-nonglaciated). It is also apparent that the lithologic contrast/fracture displaying high resistivity values on the east side of Cottonwood Canyon may be contributing water to the alluvial area. The resistivity high on the east side of Cottonwood Canyon is due to a series of small seeps and springs in the Blackhawk Formation forming on the down dip portion of the Straight Canyon Syncline (examples of springs: 91-72, 91-73 and minor seeps between Cottonwood Canyon Spring and Roans Canyon Spring).

Cottonwood Spring, located at station #880 (elevation 7749) on Line CCCR-2, is fed by flow from the water coursing downstream through the alluvium with additional flow contributed from the lithologic contrast/fracture on the east side of Cottonwood Canyon. Discharge rates from the spring area would reflect the level of groundwater within the alluvial deposits and the recharge both to the alluvial deposits and the strata above the Blackhawk Formation on the south side of Cottonwood Canyon.

Maximum alluvial depths (depth to bedrock estimates) within the survey area appear to range from 40 to 70 feet. These estimates are dependent upon the configuration of the survey spacing, lithologic contrast and the presence of groundwater. As discussed in the resistivity results (see Volume 9, Hydrologic Support Information - Results of Resistivity-Induced Polarization Survey, Rilda and Cottonwood Canyon Creek: East Mountain Property) electrode separation for profiling in Cottonwood Canyon Creek consisted of four 20-foot spacings with a horizontal setup interval of 20 feet. Although this provides a very dense data pattern, the maximum depth of penetration is roughly seventy to eighty percent of the maximum spacing, or approximately 50 to 60 feet. Generally, 50 to 60 feet of penetration was adequate for determining the depth to bedrock contrast, but in areas where the presence of groundwater or lithologic contrast existed with the alluvium (resistivity highs) and coincided with the maximum depth of penetration, the depth to bedrock was biased toward those factors. As the drilling of the alluvial wells indicated (discussed in detail in the following section), the depth to groundwater/saturated alluvium or lithologic contrast within the alluvium was fairly consistent with the pseudosections conducted perpendicular to the line of well locations. The depth estimates on the road profile CCCR-7 do not reflect maximum alluvial thickness since the cross profiles indicate maximum depths further eastward in the center of the drainage.

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## 5. DRILLING RESULTS

To delineate any potential impact to the first aquifer-saturated zone below the lowest mineable seam (Starpoint Sandstone-Spring Canyon Member), PacifiCorp proposed to drill a series of wells in Cottonwood Canyon downgradient of the existing and proposed mine development (see map in Appendix F, Volume 9 of the PAP). The proposed locations were originally submitted to DOGM on March 23, 1992. An on site location review was held with the Forest Service and DOGM on June 4, 1992 to finalize the site locations. It was agreed that a total of three sites would be completed, one south and two north of the Roans Canyon fault system. At each of the three proposed sites (one alternate site was chosen should difficulties arise during the permitting process or site access) two single completion wells were installed, one in the colluvial/alluvial deposits and one in the first saturated zone (Star Point Sandstone - Spring Canyon Member). Holes completed in the colluvial/alluvial deposits will be utilized to compare the well hydrographs to those of Cottonwood Canyon Creek and the Spring Canyon Member. The locations were selected for the following reasons:

a. Location of the drill sites was based on the regional dip of the top of the Spring Canyon Member of the Starpoint Sandstone Formation and positioned downgradient of the projected mine workings of the Deer Creek Mine.

b. Site selection was also based on the confinements of drilling in Cottonwood Canyon as well as to minimize environmental impacts. The sites did not require extensive site preparation (crossing the stream was not necessary) and were positioned at least 500 feet from existing natural gas wells.

c. The sites are as close to the western limit of East Mountain Federal Coal leases and will allow year-round access. Positioning the holes in the canyon also minimized the depth necessary to intersect the Starpoint Sandstone.

d. To document changes in hydrologic and climatic characteristics encountered in previous drilling programs (U.G.M.S. Drill Hole 3, Bulletin 112).

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Drilling of the wells was initiated on November 17, 1992 and was completed on January 19, 1993. Six (6) wells were drilled, and five (5) were completed for hydrologic monitoring. Data regarding coal thickness is confidential and is being withheld from this submittal. The following table lists the hole identification, location, depth drilled, screened zone, and initial water level (review Annual Hydrologic Reports for monitoring information).

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| 1992 COTTONWOOD CANYON DRILL HOLE DATA | | | | | |
|---|---|---|---|---|---|
| HOLE ID | LOCATION SEC/TOWN/RANGE | DEPTH DRILLED | SCREEN ZONE | WATER LEVEL | WELL ELEVATION |
| CCCW-1A | 14/17S/6E | 136' | Alluvium | 112.2' | 7843.2 |
| CCCW-1S | 14/17S/6E | 720' | Star Point Sandstone | 189.0' | 7844.5 |
| CCCW-2A | 11/17S/6E | 136' | Alluvium | 30.8' | 8133.9 |
| CCCW-2S | 11/17S/6E | 760' | Star Point Sandstone | * | N/A |
| CCCW-3A | 2/17S/6E | 110' | Alluvium | 56.0' | 8369.7 |
| CCCW-3S | 2/17S/6E | 740' | Blackhawk<br>Star Point Sandstone | 77.7'<br>597.6' | 8367.6 |

* Casing imploded, permanently sealed

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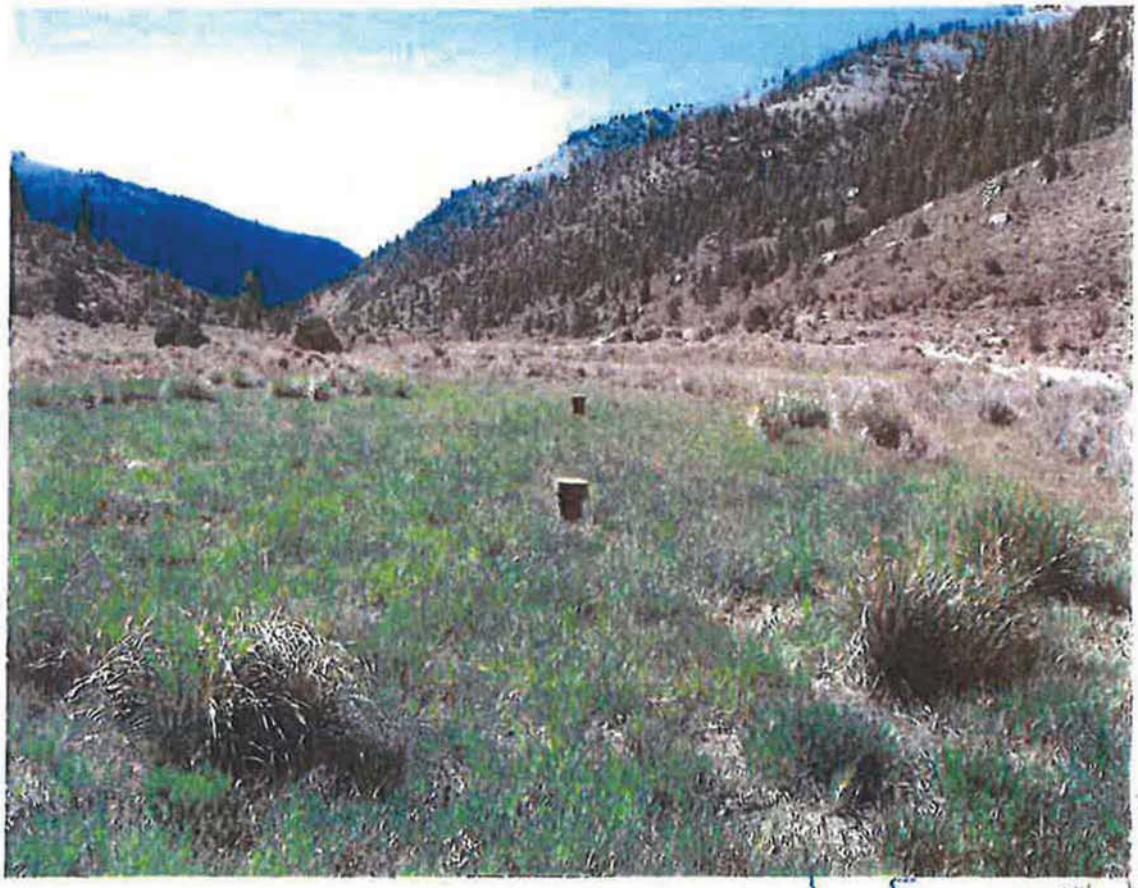
## Drill Site #1



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**Hole CCCW-1A**

Drilling Procedure and Well Design

Well CCCW-1A was drilled utilizing a standard rotary type drill rig and standard drilling procedures (air mist and soap). A twelve-inch (12") diameter hole was drilled to a depth of twenty (20) feet where eighteen (18) feet of 9-5/8" steel surface casing was set and grouted. The remainder of the hole was drilled to a diameter of 8-5/8" to a total depth of one hundred thirty-six (136) feet. Bedrock was encountered at a depth of one hundred twenty (120) feet (review lithologic log in Volume 9 - Hydrologic Support Information: East Mountain Drill Holes). A review of the resistivity data (transect line CCCR-3)

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indicates a resistivity high along the estimated bedrock boundary. During drilling, damp alluvium was encountered at a depth of forty (40) feet. Upon completion the static level was measured on January 14, 1993 at 112.2 feet, or an elevation of 7731.0 feet (review Well Completion Information in Volume 9 - Hydrologic Support Information). This elevation approximately equals the elevation where the groundwater reemerges from the alluvium at Roans Spring (see map HM-1, Volume 9 of the PAP).

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**Hole CCCW-1S**

Drilling Procedure and Well Design

Well CCCW-1S was drilled utilizing a standard rotary type drill rig and standard drilling procedures (air mist and soap). A twelve-inch (12") diameter hole was drilled to a depth of one hundred sixty (160) feet where one hundred forty (140) feet of 9-5/8" steel surface casing was set and grouted to isolate the alluvial deposits from the lower stratigraphic units. The remainder of the hole was drilled to a diameter of 8-5/8" to a total depth of seven hundred twenty (720) feet. The first measurable groundwater inflow occurred at approximately five hundred eighty (580) feet, which is twenty-three (23) feet above the Hiawatha Seam. Groundwater inflow increased with depth, especially in the upper fractured portion of the Starpoint Sandstone (see lithologic log in Volume 9 Hydrologic Support Information: East Mountain Drill Holes). The strata above the fluvial sandstone which occurs from 569.5 feet through 590.5 feet formed an effective barrier to vertical migration of groundwater. Well completion included setting screen in the upper Starpoint member and isolating the upper member of the Starpoint from the Blackhawk Formation (see well development data in Volume 9 - Hydrologic Support information: Well Completion Section). Upon completion the static water level was measured on January 15, 1993 at one hundred eighty-nine (189) feet, or an elevation of 7655.5 feet. The static pressure above the Hiawatha is equivalent to 179 psi. In reviewing the resistivity results (lines CCCR-3 and CCCR-7) and lineament projections from aerial photos, drill hole CCCW-1S was slightly north of the southernmost fault extension of the Roans Canyon fault system. Estimated static pressure of 179 psi above the Hiawatha Seam is comparable to the data collected in previous investigations of the Roans Canyon fault system. Pressures recorded in the Deer Creek Mine 3rd North fault investigation projects [Blind Canyon Seam, stratigraphy located approximately eighty (80) feet above the Hiawatha seam] ranged from 110 to 90 psi or 145 to 125 ft, respectively, based on the elevation of the Hiawatha Seam. It is apparent from reviewing the drilling and well completion data that the groundwater inflow intercepted in CCCW-1S was fracture controlled and is not hydrologically connected to the upper Blackhawk Formation or the alluvial deposits.

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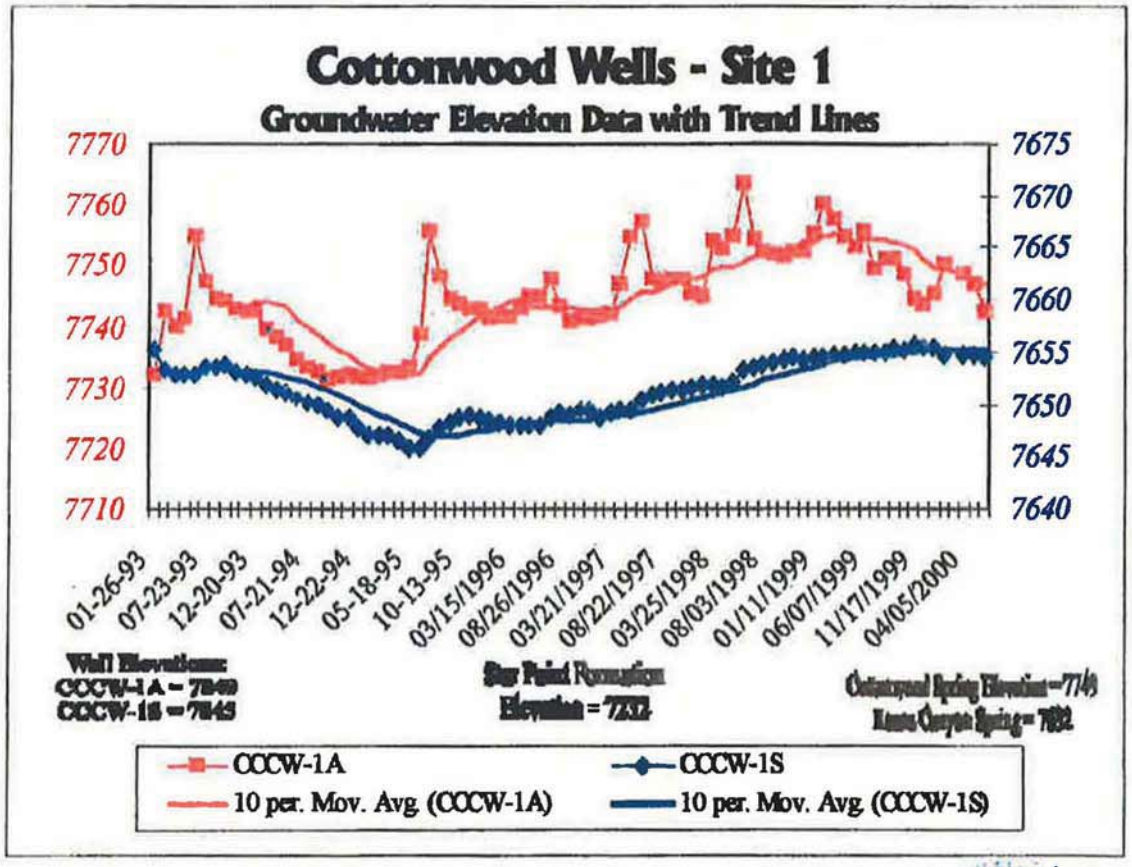
To document the hydrologic characteristics of the alluvium and the Starpoint Sandstone, PacifiCorp has collected water level information on a monthly basis since the completion of the wells. The following illustration represents data collected from 1993 to 2000.

It is evident from the trendlines that water elevation in the alluvial system varies as function of precipitation, whereas yearly responses to precipitation in the Starpoint Sandstone are less apparent.

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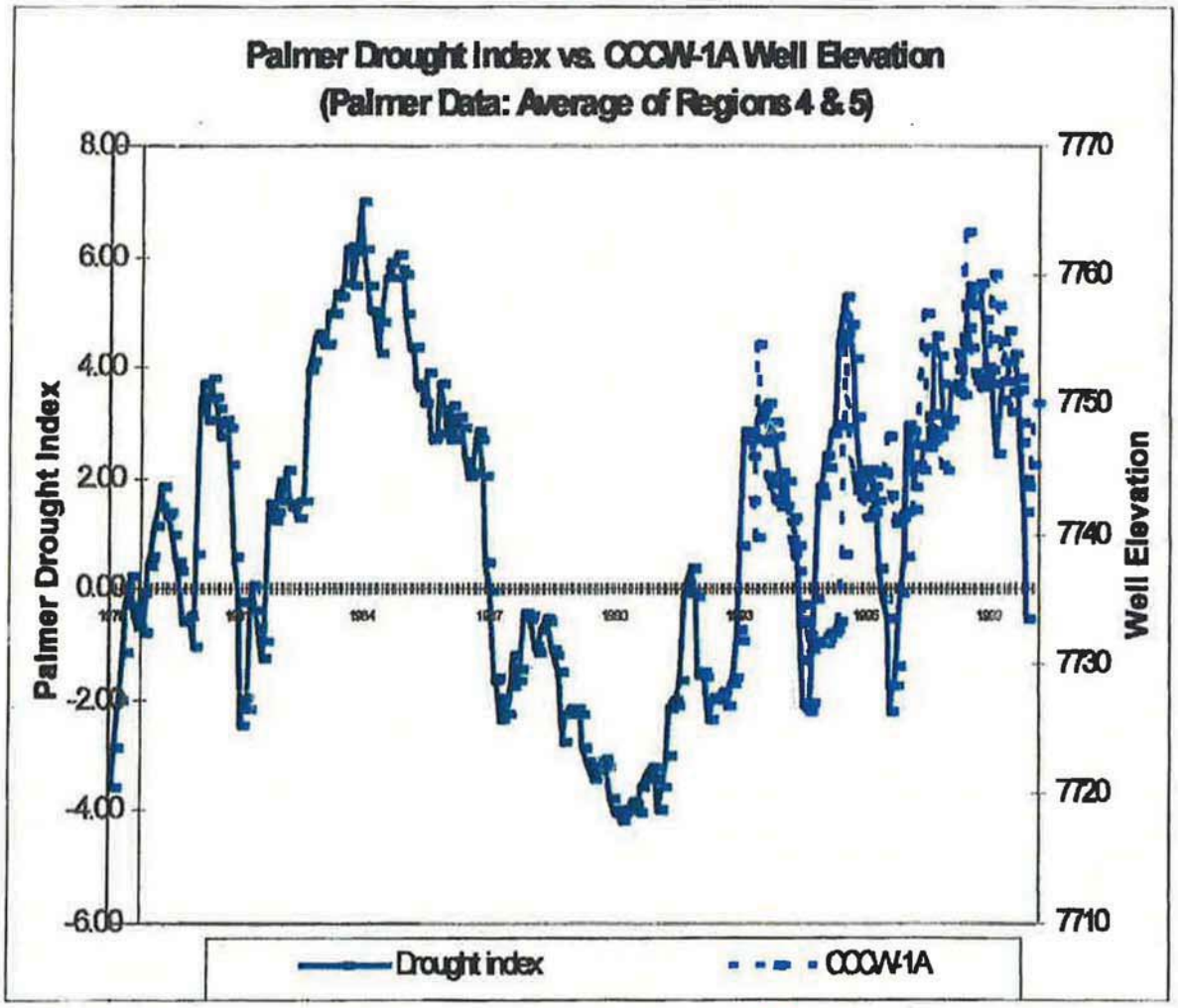
To further emphasize the correlation between the climatic and alluvial groundwater trends, the following figure compares the Palmer Drought Index to the groundwater elevations from well CCCW-1A. Well CCW-1A is located approximately 1000 feet north (up canyon) of Cottonwood Spring. The response to climatic conditions in well CCCW-1A is rapid.

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**Drill Site #2**

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**Hole CCCW-2A**

Drilling Procedure and Well Design

Drill site #2 was moved from the proposed site to the alternate site due to the small size of the proposed site and poor weather. Well CCCW-2A was drilled utilizing a standard rotary type drill rig and standard drilling procedures (drilling mud was utilized to stabilize the hole). A twelve-inch (12") diameter hole was drilled to a depth of twenty (20) feet where eighteen (18) feet of 9-5/8" steel surface casing was set and grouted. The remainder of the hole was drilled to diameter of 8-5/8" to a total depth of one hundred thirty-six (136) feet. Bedrock was encountered at a depth of one hundred ten (110) feet (review lithologic log in Volume 9 - Hydrologic Support Information: East Mountain Drill Holes). A review of the resistivity data (Volume 9 - Hydrologic Support

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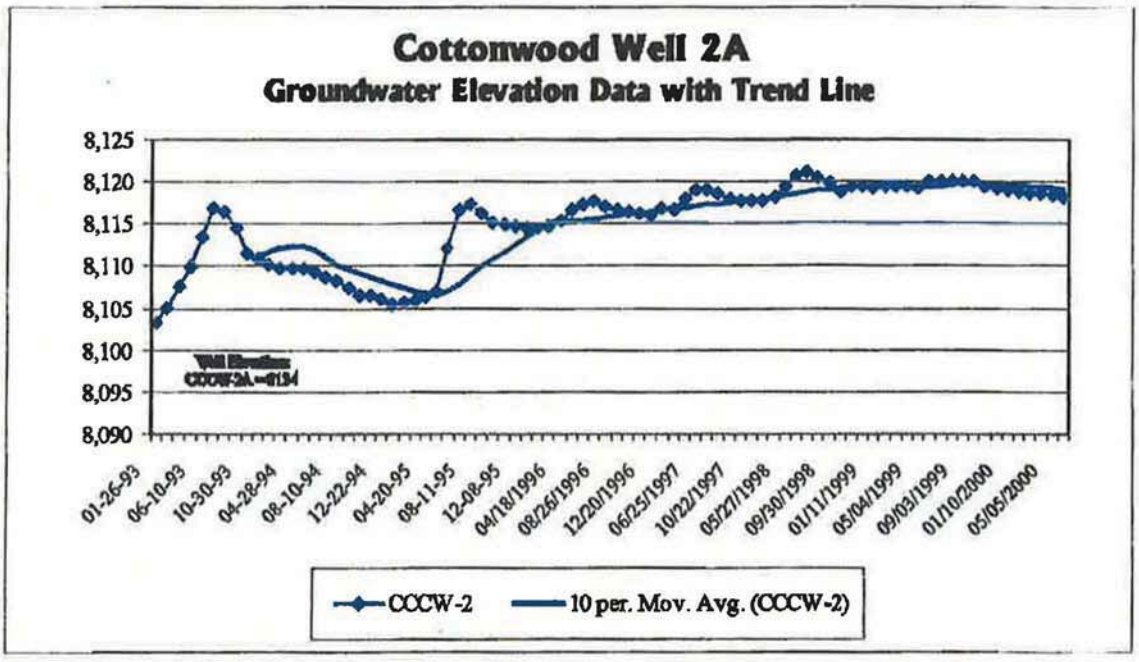
Information: Cottonwood Canyon Creek Resistivity-I.P., transect line CCCR-5) indicates a buried gas line caused the depth to bedrock estimates to be less accurate than transects without cultural effects. During drilling saturated alluvium was encountered at a depth of forty-five (45) feet. Upon completion the static level was measured on January 26, 1993 at 30.76 feet, or an elevation of 8103.1 feet (review Well Completion Information in Volume 9 - Hydrologic Support Information).




Water elevations in CCCW-2A vary with precipitation trends similar to CCCW-1A. It is also apparent from the trendline that alluvial system is recharging in response to precipitation.

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**Hole CCCW-2S**

Drilling Procedure and Well Design

Well CCCW-2S was drilled utilizing a standard rotary type drill rig and standard drilling procedures. Drilling mud was utilized to stabilize the alluvial deposits prior to setting the surface casing. Air mist/soap was used to drill the remaining portion of the hole. A twelve-inch (12") diameter hole was drilled to a depth of one hundred ninety (190) feet, where one hundred eighty-eight (188) feet of 9-5/8" steel surface casing was set and grouted to isolate the alluvial deposits from the lower stratigraphic units. The remainder of the hole was drilled to diameter of 8-5/8" to a total depth of seven hundred sixty (760) feet. The first measurable groundwater inflow (<5 GPM) occurred at approximately seven hundred thirty (730) feet, which is sixty-four (64) feet below the Hiawatha Seam. Groundwater inflow remained less than 5 (<5) GPM throughout the remaining portion of the upper member of the Starpoint Sandstone (see lithologic log in Volume 9 Hydrologic Support Information: East Mountain Drill Holes). Well completion included setting screen in the upper Starpoint member and isolating the upper member of the Starpoint from the Blackhawk Formation (see well development data in Volume 9 - Hydrologic Support Information: Well Completion Section). During the grouting process the PVC casing imploded and the hole was permanently sealed. The weight of the cement grout exceeded the compressive strength for 4-inch schedule forty (40) PVC pipe. Grouting procedure for the remaining Starpoint Sandstone holes was altered to prevent the casing from collapsing. A review of drilling data reveals groundwater inflow was the result of formation production intercepted in the Starpoint Sandstone below the Hiawatha Seam and was limited to less than five (<5) GPM. Based on these observations, the lower Blackhawk/Starpoint aquifer is not hydrologically connected the upper Blackhawk Formation or the alluvial deposits.

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**Drill Site #3**

**Hole CCCW-3A**

Drilling Procedure and Well Design

Well CCCW-3A was drilled utilizing a standard rotary type drill rig and standard drilling procedures (drilling mud was utilized to stabilize the hole). A twelve inch (12") diameter hole was drilled to a depth of twenty (20) feet where eighteen (18) feet of 9-5/8" steel surface casing was set and grouted. The remainder of the hole was drilled to diameter of 8-5/8" to a total depth of one hundred ten (110) feet. Bedrock was encountered at a depth of ninety-six (96) feet (review lithologic log in Volume 9 - Hydrologic Support Information: East Mountain Drill Holes). In reviewing the resistivity data (Volume 9 - Hydrologic Support Information: Cottonwood Canyon Creek Resistivity-I.P., transect line CCCR-6) which was conducted perpendicular to the hole location, the depth to bedrock was estimated at forty-five (45) feet. Discussions with Geowestern indicated that a layer of sandstone boulders would simulate bedrock in the resistivity data. During drilling, saturated alluvium was encountered at a depth of forty-five (45) feet. Upon completion the static level was measured on December 4, 1992 at 56.0 feet, or an elevation of 8313.7 feet (review Well Completion Information in Volume 9 - Hydrologic Support Information).

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**Hole CCCW-3S**

Drilling Procedure and Well Design Well CCCW-3S was drilled utilizing a standard rotary type drill rig and standard drilling procedures. Drilling mud was utilized to stabilize the alluvial deposits prior to setting the surface casing. Air mist/soap was used to drill the remaining portion of the hole. A twelve inch (12") diameter hole was drilled to a depth of one hundred forty-five (145) feet where one hundred forty-two (142) feet of 9-5/8" steel surface casing was set and grouted to isolate the alluvial deposits from the lower stratigraphic units. The remainder of the hole was drilled to 8-5/8" to a depth of one hundred sixty eight (168) feet and then down-sized to 6-1/8" to a total depth of seven hundred forty (740) feet. The first measurable groundwater inflow (≈ 55 GPM) occurred at approximately one hundred forty-six (146) feet from fractured/oxidized sandstone. The Utah Geological Mineral Survey drill hole UGMS-3 (drilled in 1975), located within approximately five hundred (500) feet of CCCW-3S, had artesian flow of one hundred fifty (150) GPM from the same stratigraphic unit (refer to the following page for a copy of page 36 of UGMS Bulletin 112, artesian flow encountered at a of depth 129).

Groundwater production from the fractured fluvial sandstone remained relatively constant at fifty to sixty five (≈ 55-65) GPM during drilling of the lower stratigraphic units (see lithologic log in Volume 9 Hydrologic Support Information: East Mountain Drill Holes). Well completion was altered to include a dual completion: lower section - set screen in the upper Starpoint member and isolating the upper member of the Starpoint from the Blackhawk Formation; upper section - set screen in the fluvial sandstone to document seasonal variations in the upper portion of the Blackhawk Formation (see well development data in Volume 9 - Hydrologic Support information: Well Completion Section). Upon completion the static level was measured on January 26, 1993 at 77.6 feet, or an elevation of 8290.0 feet, for the upper section and 597.6 feet, or an elevation of 7777.0 feet, for the lower section (review Well Completion Information in Volume 9 - Hydrologic Support Information).

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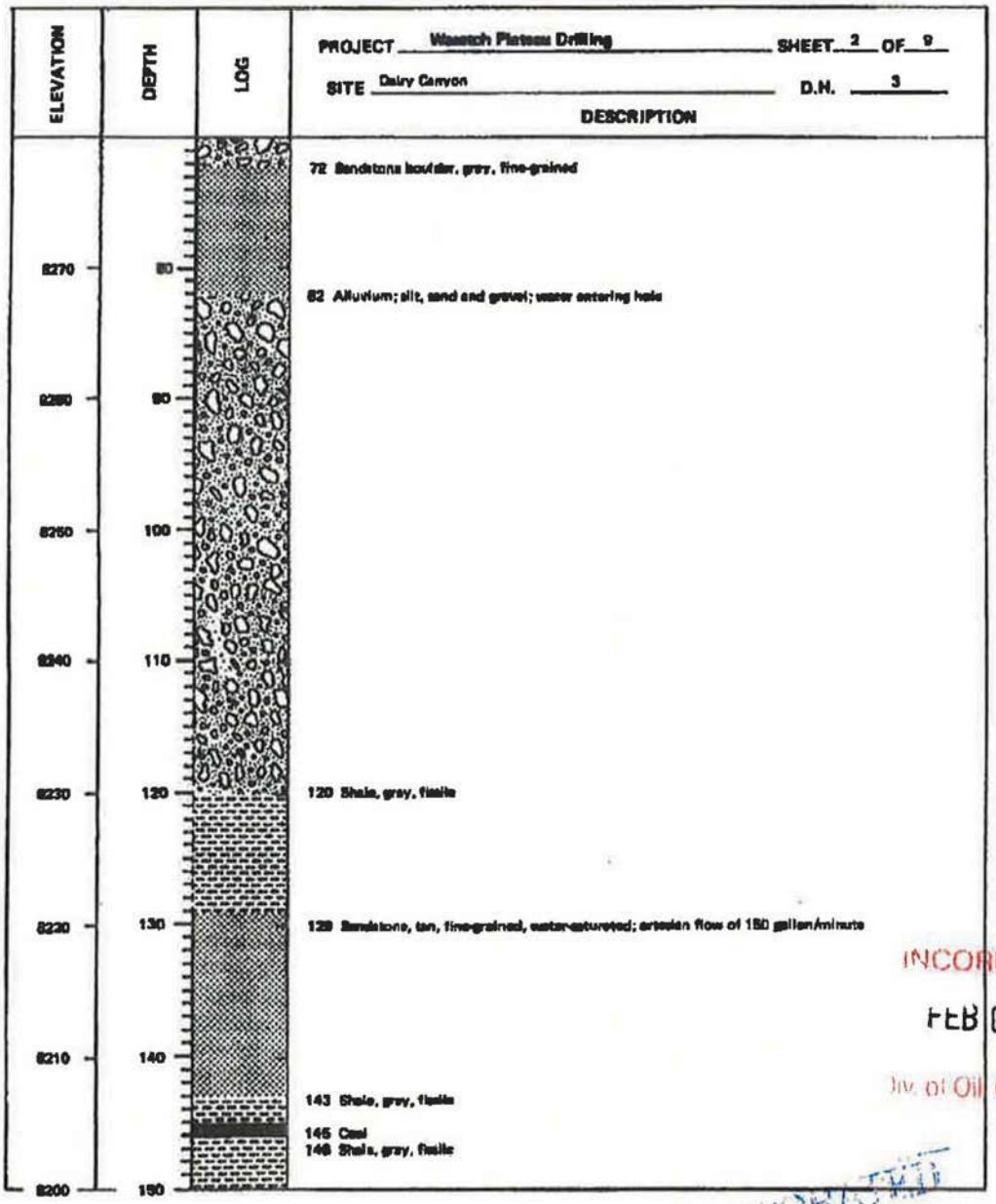


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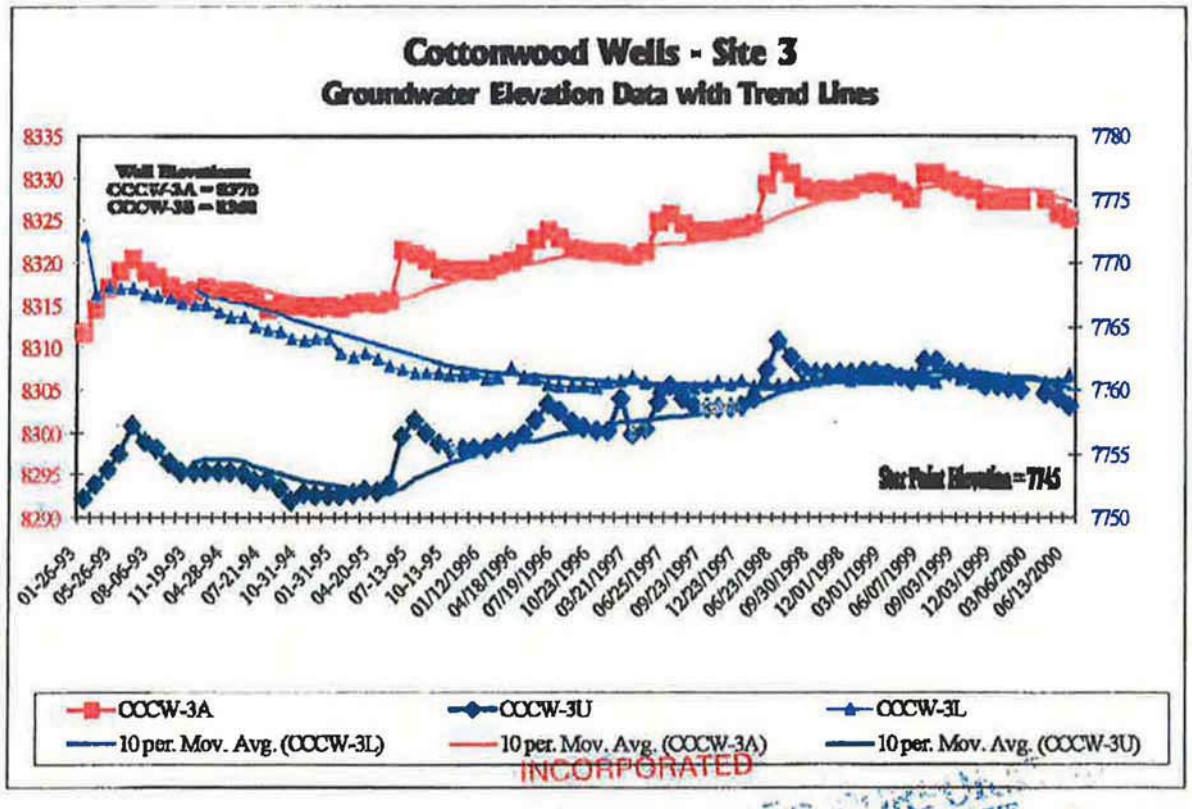
Site CCCW-3S was chosen for a variety of reasons including: 1) the ability to monitor seasonal variations in the stratigraphic units north of the Roans Canyon fault/fracture system; 2) the site is positioned downgradient of any projected mine workings; 3) site access limited impact to the surrounding area; 4) site CCCW-3S is located over two miles and up stratigraphic dip from the existing Deer Creek Mine workings; and 5) close proximity to UGMS-3 (previous hydrologic data collected during drilling of UGMS-3 could be compared to the results of CCCW-3S to document climatic patterns in groundwater production). At the same stratigraphic unit (fluvial sandstone), groundwater production from UGMS-3 was artesian flow measured at one hundred fifty (150) GPM and CCCW-3S was measured 77.6 feet below the ground surface. This would indicate a minimum reduction of head of approximately thirty four (34) psi or 77.6 feet. From reviewing the drilling, well completion data and well monitoring data (refer to well hydrograph on the following page) it is apparent that the lower Blackhawk/Starpoint aquifer is not hydrologically connected to the upper Blackhawk Formation. Water level in well CCCW-3A was measured during drilling of the upper Blackhawk Formation and the lower Blackhawk/Starpoint Sandstone. The static level remained relatively constant, indicating the alluvial deposits are not hydrologically connected to the lower stratigraphic units.

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## AQUIFER TEST RESULTS

PacifiCorp completed a "slug test" at each well to determine aquifer characteristics of the isolated zone (refer to the following table and Volume 9 - Hydrologic Support Information: East/Trail Mountain Aquifer Test Results for complete test results).

| WELL No. | Aquifer Type | PERMEABILITY (ft/min) | TRANSMISSIVITY ($ft^2$/min) |
|---|---|---|---|
| CCCW-1A | Unconfined | 5.814E-5 | NA |
| CCCW-2A | Unconfined | 9.387E-5 | NA |
| CCCW-3A | Unconfined | 7.64E-5 | NA |
| CCCW-1S | Confined | 5.23E-3 | 0.5032 |
| CCCW-3 U | Confined | 1.37E-3 | 2.462E-2 |
| CCCW-3S L | Confined | 2.97E-5 | 2.453E-3 |

## 7. DATA FROM MAYO & ASSOICATES

In 1996, as a part of comprehensive review of the surface and groundwater systems of East and Trail mountains, Mayo & Associates collected stable and unstable isotopic data from the alluvial groundwater system in Cottonwood Canyon at Roans Spring, water from the Star Point Sandstone formation isolated in well CCCW-1S, and in-mine groundwater sources. The $^{14}C$ and $^{3}H$ compositions of the spring and well water (see the following table) indicate that it is of modern origin and is not related to the deep groundwater systems encountered within the mines. The interception of groundwaters within the mine workings, therefore, does not adversely impact groundwater flow rates in the alluvial springs in Cottonwood Canyon (refer to the following table and Volume 9 – Hydrologic Support Information: Mayo & Associates Study for complete study results).

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# Cottonwood Canyon Isotopic Data

| Sample Location | Sample Date | $^{14}C$ (pmc) | $^{3}H$ (TU) | Mean Residence Time (Years) |
|---|---|---|---|---|
| Roans Canyon Spring | 4/2/96 | 73.24 | 11.2 | Modern |
| 91-72 | 12/14/96 | 75.47 | 14.9 | Modern |
| 91-73 | 12/15/96 | 79.49 | 2.63 | Modern |
| MW Seals Cottonwood Mine | 2/26/97 | 21.99 | 1.34 | 8,000 |
| 3rd South Seals Deer Creek Mine | 2/26/97 | 14.4 | 0.88 | 12,000 |
| CCCW-1S | 12/9/96 | 46.17 | 1.10 | 1,000 Mixed |

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8. DOGM FINDINGS

The Division of Oil, Gas and Mining's initial findings dated September 11, 1991, indicated that with existing information it was possible to show that the Deer Creek Mine had intercepted significant groundwater quantities which may have caused the decreased flow at the spring (see Attachment 1). In addition, the Division produced a chronology of events related to Cottonwood Spring and the Roans Canyon Graben crossing (internal memo dated October 16, 1998). The Division listed several areas of concern which are discussed and refuted below.

*Cottonwood Canyon Wells*

"The ground water conditions reported from the Cottonwood Creek wells do not support the company's theory that the spring was alluvial water...."

As shown earlier, ground water elevations in the Cottonwood Canyon Creek alluvial system vary as a function of precipitation and wells which isolate the Star Point Sandstone trend independently from precipitation (CCCW-1S is less apparent due to well completion). As the graphs illustrate, (review Drilling Results – Drill Site No. 1, Groundwater Elevation Data with Trend Lines and Palmer Drought Index vs. CCCW-1A Well Elevation), central Utah experienced dramatic shift climate patterns from extremely above normal precipitation from 1982 through 1986 to a extreme drought from late 1986 through 1993. As the climatic patterns returned to a normal pattern in 1993, groundwater in the alluvial system began to recharge. Recharge to the alluvial system peaked in early 1999 and began a downward trend. PacifiCorp stated in the MRP and meetings concerning Cottonwood Spring, as the alluvial system recharged, flow from the Cottonwood Spring area would re-develop. Based on the groundwater trends in well CCCW-1A, PacifiCorp initiated gain/loss surveys of Cottonwood Canyon in 1998 to confirm experienced in the monitoring wells and to document areas of groundwater discharge. Gain/loss surveys were conducted throughout reach of Cottonwood Canyon from Mill Canyon in Section 2, Township 17 South, Range 6 East to below Roans Canyon in Section 24, Township 17 South, Range 6 East. Station selection was based upon areas of detected change and to duplicate previous research (USGS). As discussed earlier, data collected compared directly to the climatic trends and to the data collected by the USGS (refer to Attachment 5 for Gain/Loss Survey Data). Over a two year period (1998-2000), flow from the Cottonwood Spring area ranged from approximately 100 gpm to 40 gpm.

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*Cottonwood Canyon Wells: Groundwater Flow*

The Division staff calculated the amount of water flowing through the alluvium based upon slug test results conducted on the alluvial wells. Based on the assumptions used, the Division surmised the alluvial system was incapable of producing the volume of water historical recorded from the spring site. In reviewing the lithologic logs of the completed alluvial monitoring holes, site visits with the Division staff and numerous

meetings, the alluvial deposits of Cottonwood Canyon were shown to consist of stratified layers of very fine silt to large boulders. The following photo illustrates the stratified deposits of Cottonwood Canyon (photo of eroded banks near Cottonwood Spring).

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During development of the alluvial monitoring wells, several zones of "flowing sediments" were encountered. Well screen and sand were selected to protect of the integrity of the well and individual sediment sequences were not isolated. Overall, the hydrologic test results represent the entire sequence and not individual sediment horizons. The alluvial wells were installed to monitor changes in the groundwater elevations, not for the purpose of hydrologic testing.

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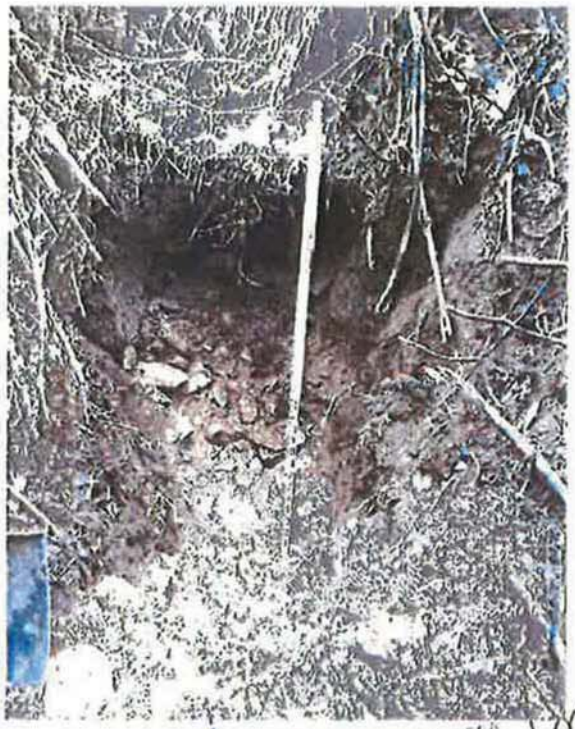
In alluvial systems like Cottonwood Canyon, horizontal component of flow is a key factor in movement of groundwater and dictates areas of surface flow. As the gain/loss surveys conducted by PacifiCorp revealed, surface flow of Cottonwood Canyon includes several areas of groundwater recharge and discharge. One area of groundwater discharge is the Cottonwood Spring area. As previously discussed, PacifiCorp excavated the site (only hand shovel required) to verify the development construction. A three (3) inch PVC pipe, approximately three [3] feet in length, was simply inserted into coarse gravel lens with soil compacted around the pipe (see adjoining photo). The gravel lens is approximately two (2) feet thick and is heavily oxidized indicating near surface influence. As discussed with the Division and regulatory staffs, the area of recharge of Cottonwood Spring exists up-canyon and the discharge area is a function of change in topography from glacial to non-glacial terrain.



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*Timing of Mining*

The Division staff documented the apparent timing of interception of groundwater in the Deer Creek Mine and the reduced flows of Cottonwood Spring. Two areas were discussed, 1) installation of test wells to analyze the hydrologic characteristics of the Roans Canyon Graben, and 2) interception of groundwater in the 4th South longwall panel area.

As documented in MRP, PacifiCorp initiated two separate hydrologic testing programs to quantify hydrologic aspects of the Roans Canyon Graben as preparation for crossint the fault zone to access additional reserves north of the fault. The first program was conducted in 1985 and the second in 1988. Drill holes completed in 1985 were small diameter (AW; <2"), and were shut in after completing each hole (five holes were completed in 1985). A constant rate drawdown test was conducted utilizing drill hole #4 at a rate of 35 gpm for 1700 minutes. After the test was completed, all wells were shut in and capped. Prior to the 1988 test, the 1985 drill holes were inspected for possible inclusion in the 1988 program. All of the holes completed in 1985 were squeezed shut or plugged, and were not included in the 1988 project.

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A total of five holes were completed in 1988. After the completion of each test well, a short duration discharge test were conducted (normally <30 minutes) to evaluate the well completion techniques. As documented in the Hydro-Search Report, the original design used on wells TW-6 and TW-7 was abandoned because the casing (1 1/4") excessively restricted ground water discharge and the casing material (PVC) collapsed due to high lithostatic pressures (open hole flow from the completed well TW-7 was <45 gpm). After completion of the five holes (TW-6 through TW-10), aquifer zones were allowed to stabilize from Sept. 2-10, 1988. A drawdown test was initialized on Sept. 10, 1988 using TW-10 with a constant flow rate set at 76 gpm for a duration of 10,000 minutes.

The purpose of the 1988 program was two-fold: 1) to evaluate and confirm the 1985 Hydrologic Test results, and 2) to analyze de-watering scenarios (slope construction with and without de-watering and grouting). Based upon the 1988 test results, Hydro-Search recommended de-watering the fault zones prior to slope development and grouting to control local ground water inflow after slope construction. Test wells completed in 1988 were analyzed for de-watering potential, and the same conditions which rendered the 1985 wells unusable (flow constrictions due to casing failures) also hampered the 1988 wells. Only test well TW-10 functioned as originally designed and has been monitored since December 1988 (see attached graph). Flow from well TW-10 dissipated rapidly from ≈40 gpm to <5 gpm. Due to the ineffectiveness of the de-watering wells, PacifiCorp initiated a grouting program during slope development to minimize ground water inflow. Grout holes were drilled around the circumference of the tunnels prior to the fault zones to develop a grout "curtain". As a result, long term ground water inflow from the Roans Canyon Fault crossing tunnels has been less than originally projected and averages <30 gpm.

The second point of mine timing the Division listed was the interception of large quantities of groundwater in the Deer Creek Mine (interception of the Roans Canyon fault, in the 4th South longwall panel area). As the following figure illustrates, a sympathetic fault of the Roans Canyon Graben was intercepted in 1st and 2nd Right in early 1990. As documented earlier, flow from Cottonwood Spring dissipated (recorded flow 0.0 June 1988) prior to the interception of groundwater from the sympathetic fault.

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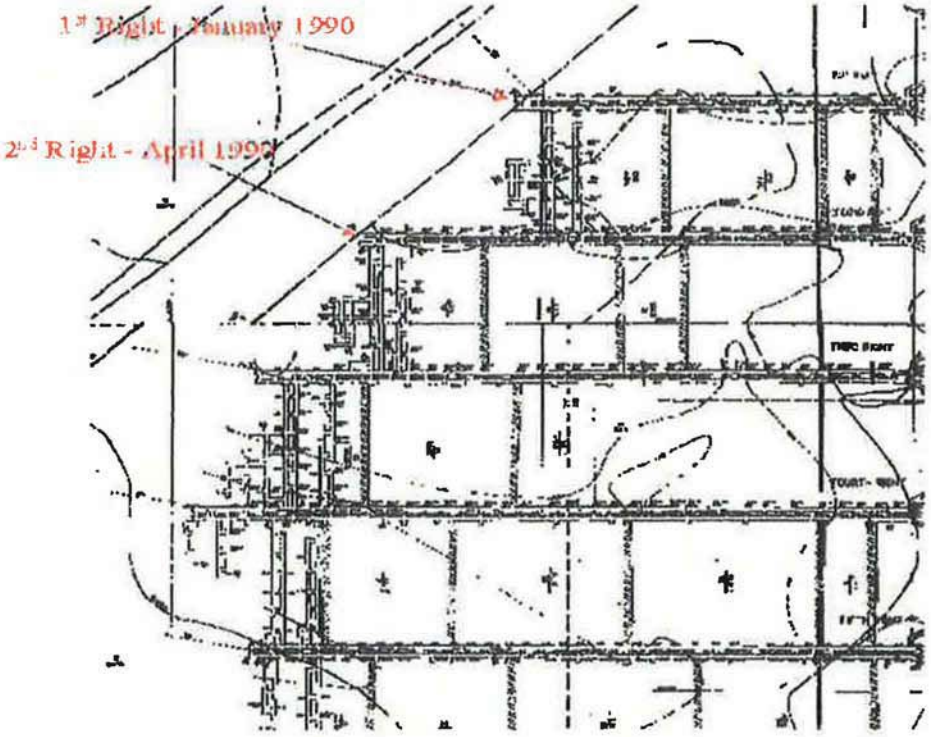
## Deer Creek Mine
## 4th South Area
## Intercepted Roans Canyon Fault

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During meetings with the regulatory agencies, PacifiCorp presented data and maps to demonstrate that the upper Blackhawk strata in Cottonwood Canyon were unsaturated between the alluvial deposits and the coal seam interval. Map HM-12 was developed and included in Volume 9 to show the hydrogeology of the Cottonwood Canyon and includes cross sections through East and Trail mountain. In addition to the work completed by PacifiCorp, Mayo & Associates was hired to develop a comprehensive hydrogeologic model of East Mountain and Trail Mountain. As the study documented, intercepted groundwater in PacifiCorp's East & Trail mountain properties is not hydraulically connected to surface water resources (refer to Hydrologic Support Information).

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*Stiff Diagrams*

The Division's September 11, 1991 investigation of Cottonwood Spring concluded, "Stiff diagrams reflected very consistent quality, with little seasonal fluctuation, indicating that the source was from groundwater and not alluvial water". As document in the Volume 9 and in numerous meetings, water quantity from near surface alluvial systems can vary rapidly from season to season but quality will remain fairly constant. PacifiCorp, in corporation with North Emery Water Users Association, has conducted several studies of a similar alluvial system located in Rilda Canyon. Alluvial discharge in Rilda Canyon can vary from 80 to 300 gpm during the runoff season and the quality will remain constant.

*Oxidation at 2000' depth*

As the Division's October 16, 1998 report states "that surface water was reaching the mine 2000 feet below the ground surface, since large areas were oxidized at the mine level along the Roans Canyon Fault crossing". The report went on to utilize the observed Roans Canyon test wells elevations in direct comparison to the elevation of Cottonwood Spring. The Division ignored information reported in Volume 9 and the hydrologic investigation Roans Canyon fault crossing concerning horizontal gradient, location of the crossing and hydrogeologic information of the Roans Canyon intercept in the 4th South area of the Deer Creek Mine.

- As reported in the Roans Canyon hydrologic investigation, the horizontal gradient shown in the test wells was dipping steeply dipping from west to east towards Meetinghouse Canyon, away from the direction of Cottonwood Spring.
- The Roans Canyon fault crossing at 3rd North is located in close proximity (less than one mile) to the right fork of Meetinghouse Canyon and isotopic data indicates that the source of water is of modern age (refer to Volume 9 – Hydrologic Support Information: Mayo & Associates report).
- The 4th South Roans Canyon fault intercept (located approximately two [2] miles west of the 3rd North fault crossing) was not oxidized, and isotopic data indicates the water intercepted was "old water", in excess of ten thousand (10,000) years old and therefore not hydraulically connected to the surface systems.

*Mine Discharge Graphs*

The Division's report describes historical water production and incorrectly accounts for changes in the hydrograph. As stated in the report, "water production began increasing in 1985 when the mine workings were approaching the graben and exploratory drilling commenced. Major increases in mine water discharge in 1988 was probably due to drilling into the graben for testing and dewatering purposes. The graben crossing was constructed in 1989 and additional inflows fromthe graben dewatering…".

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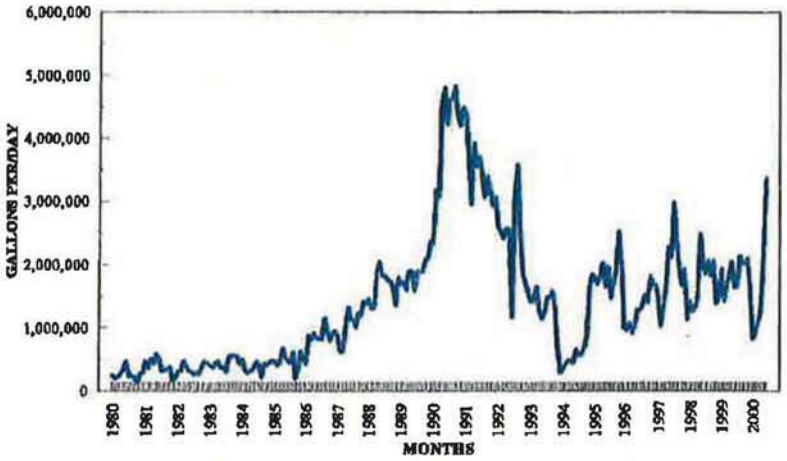
**DEER CREEK MINE DISCHARGE**

**@ Deer Creek (UPDES UT-0023604)**
**January 1980 through December 1999**




- As PacifiCorp has stated, hydrologic testing in 1985 was conducted on a limited scale with very little water production and all test wells were sealed after the hydrologic drawdown test was complete.
- The major source of groundwater interception from 1986 through 1990 was related to mining in the trough of the Straight Canyon Syncline in areas dominated by water saturated fluvial sandstone channel deposits (refer to HM-2, 3rd and 4th South area).
- Hydrologic investigation of the Roans Canyon conducted in 1988 included drilling a series of wells to identify hydrologic characteristics of the graben area. A total of five (5) wells were completed across the graben area. After each well was completed, flow was eliminated and pressure gauges were installed to monitor well recovery. At the completion exploration phase, a drawdown test was conducted on one (1) well, while pressure was monitored on the remaining wells. After the hydrologic test, all wells were sealed. Initial plans for the test wells included de-watering in advance of slope construction to minimize hydraulic pressures. As a result of well construction techniques and geologic conditions encountered during development, the wells never functioned as intended. As pointed out in Volume 9, PacifiCorp instituted a pressure grout system in advance of slope construction to minimize groundwater inflow and to stabilize ground conditions. As tours of the 3rd North crossing with the government agencies have shown, the grout curtain effectively isolated the rock slopes and minimized hydrologic impacts.

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*Cottonwood Creek Flows*

During the Division's October 1998 evaluation, review of Cottonwood Canyon Creek flow data was limited to the time period from 1984 through 1991 (data supplied by PacifiCorp). With this limited review, the Division stated that the base flow was generally over 1 CFS. PacifiCorp updated the Cottonwood Canyon hydrograph and supplied this information to the Division during July 1998 on-site review, which clearly shows that the base of Cottonwood Canyon Creek averages less than one half (<0.5) CFS (included previously in this appendix, Introduction /General Section). In addition, as the normal precipitation patterns returned, the Cottonwood Creek hydrograph exhibits flow characteristics similar to historical data.

***Conclusion of Department of Oil, Gas & Mining Cottonwood Spring Study***

On October 27, 1998 the Division sent a letter to the Bureau of Land Management and the United States Forest Service that stated, "The Division has made an extensive review of this issue (Cottonwood Spring) and has made findings to conclude the complaint. By this letter and enclosed memos, the Division also concludes the issue of Cottonwood Spring. To date, no definitive connection between Cottonwood Spring has been cited or proven in relation to mining at the Deer Creek Mine. Hopefully, this documentation from our division will provide the needed paperwork for the US Forest Service and the Bureau of Land Management to move forward with the lease relinquishment for this area."

After the Division's findings were sent to subsuface and surface regulatory agencies, the USFS (surface owner) sent a response letter dated May 5, 1999. The letter indicated to reslove the Cottonwood Spring issue, the USFS would accept three (3) listed alternatives: 1) for PacifiCorp to conduct gain/loss surveys for a two year period to confirm hydrologic trends, 2) for PacifiCorp to restore perennial flow of like quantity and quality at or above Cottonwood Spring, or 3) for PacifiCorp to finance manipulation of existing watershed to increase water yield. PacifiCorp did not receive an official notification from the USFS or the Division concerning these alternatives listed above. Findings listed in the USFS letter dated May 5, 1999 consist of the same inconsistencies which were discussed above.

To help resolve and bring closure to the Cottonwood Spring issue, for the last two years PacifiCorp has voluntarily conducted periodic gain/loss surveys of Cottonwood Canyon area. As detailed earlier, (refer to Cottonwood Canyon gain/loss Surveys), gain/loss surveys included measurements collected along the Cottonwood drainage from Mill Canyon in Section 2, Township 17 South, Range 6 East to below Roans Canyon in Section 24, Township 17 South, Range 6 East (refer to Attachment 4). These surveys included measurements of each of the contributing sub-drainages and Spring 91-72. Depending upon flow, quantity data was collected at each site utilizing either the bucket/stop watch method or by temporarily installing a 90° v-notch weir.

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displacements ranging from a few feet to over 150 feet. PacifiCorp has conducted extensive studies to document the hydrologic significance of the graben structure. (See Volume 9, R645-301-711, A. Existing Groundwater Resources: Structural Hydrologic Features). Based on research conducted by PacifiCorp, faulting along the Roans Canyon system occurred during two phases -- during the first (east-west compression phase) strike slip movement occurred prior to the deposition of the Flagstaff Limestone; during the second (east-west tension phase) normal faulting occurred along strike slip faulting plane resulting in the formation of a graben structure. Displacement along the Roans Canyon Fault system increases to the north until it is terminated by the Pleasant Valley Fault system. In the area of Cottonwood Canyon Creek, the Roans Canyon Fault system consists of two or more fractures with little or no displacement.

During the resistivity study a second linear feature, which could possibly be a southern extension of the Mill Fork Canyon fault system, was detected on transect line CCCR-5. The southernmost fault of the Mill Fork Canyon Graben was intersected in Arco's Beaver Creek #4 Mine in Mill Fork Canyon and has a displacement of about twenty (20) feet down on the northwest side. Where the fault crosses the northern end of East Mountain, the fault has a displacement of about thirty (30) feet down on the northwest side.

* Cottonwood Canyon Creek is a major drainage system where evidence of glaciation exists. From the headwaters to Section 24, Township 17 South, Range 6 East the canyon is characterized by U-shaped valleys with associated lateral and terminal moraine deposits. Lateral moraine deposits most commonly occur at the intersection with side canyons. Terminal moraine deposits occur at the northwest corner of Section 24, and from this point to near the confluence with Straight Canyon the canyon can be characterized as a V-shaped valley with little evidence of glaciation.

* Based upon the results of the resistivity and induced polarization study it is apparent that the depth of the alluvium is relatively consistent throughout the length of the canyon surveyed, but the lateral extent of the deposits increases from north to south to a point just north of CCCR-2. The pseudosections indicate that the fractures/faults cutting the lower end of the Cottonwood Canyon impound water in the alluvium approximately 300-500 feet up-canyon from the fracture/fault. The pseudosections also indicate that the level of groundwater increases in the area of Cottonwood Spring due to the change in the volume of the alluvium caused by change in geomorphology (glaciated-nonglaciated). It is also apparent that the lithologic contrast/fracture displaying high resistivity values on the east side of Cottonwood Canyon may be contributing water to the alluvial area.

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Cottonwood Spring, located at Station # 880 on Line CCCR-2, is probably fed by flow from the water coursing through the alluvium with additional flow contributed from the lithologic contrast/fracture on the east side of Cottonwood Canyon. Discharge rates from the spring area would reflect the level of groundwater within the alluvial deposits and the recharge both to the alluvial deposits and the strata above the Blackhawk Formation on the south side of Cottonwood Canyon. Maximum alluvial depths within the survey area appear to range from 40 to 70 feet. General resistivity highs within the alluvium indicate an abundance of fresh water. The depth estimates on the road profile CCCR-7 do not reflect maximum alluvial thickness since the cross profiles indicate maximum depths further eastward in the center of the drainage.

* To delineate any potential impact to the first aquifer-saturated zone below the lowest minable seam (Starpoint Sandstone-Spring Canyon Member) PacifiCorp developed a series of wells downgradient of the existing and proposed mine development. The proposed locations were originally submitted to DOGM on March 23, 1992. An on site location review was held with the Forest Service and DOGM on June 4, 1992 to finalize the site locations. It was agreed that a total of three sites would be completed, one south and two north of the Roans Canyon fault system. Drilling of the wells was initiated on November 17, 1992 and was completed on January 19, 1993. Six (6) wells were drilled, and five (5) were completed for hydrologic monitoring. At each of the three sites two single completion wells were installed (except for CCCW-2), one in the colluvial/alluvial deposits and one in the first saturated zone below the lowest minable seam (Spring Canyon Member of the Star Point Sandstone). An additional well was developed in the Blackhawk Formation at site CCCW-3.

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It is apparent from the drilling results that groundwater production greater than five (>5) GPM was fracture controlled and inflow from non-fractured strata was less than five (<5) GPM. Based on the drilling and well completion data the lower Blackhawk/Upper Starpoint is not hydrologically connected to the upper Blackhawk Formation or the alluvial deposits, even in the area of the Roans Canyon Fault trace. In reviewing the data from drill site CCCW-3S, the effects of the drought in the upper Blackhawk Formation are evident. At the same stratigraphic unit, fluvial sandstone, groundwater production from UGMS-3 was artesian flow measured at one hundred fifty (150) GPM, and CCCW-3S was measured 77.6 feet below the ground surface. This would indicate a minimum reduction of head of approximately thirty-four (34) psi or 77.6

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feet. At well CCCW-1A the static level was measured on January 14, 1993 at 112.2 feet, or an elevation of 7731.0 feet. This elevation approximately equals the elevation where the groundwater reemerges from the alluvium at Roans Spring.

Monitoring of the wells completed has shown that water elevations in the Cottonwood Canyon Creek alluvial system vary as a function of precipitation and wells which isolate the Star Point Sandstone trend independently from precipitation (CCCW-1S is less apparent due to well completion). As the graphs illustrate, (review Drilling Results – Drill Site No. 1, Groundwater Elevation Data with Trend Lines and Palmer Drought Index vs. CCCW-1A Well Elevation), central Utah experienced dramatic shift climate patterns from extremely above normal precipitation from 1982 through 1986 to an extreme drought from late 1986 through 1993. As the climatic patterns returned to a normal pattern in 1993, groundwater in the alluvial system began to recharge. Recharge to the alluvial system peaked in early 1999 and began a downward trend. PacifiCorp stated in the MRP and meetings concerning Cottonwood Spring, as the alluvial system recharged, flow from the Cottonwood Spring area would re-develop. Based on the groundwater trends in well CCCW-1A, PacifiCorp initiated gain/loss surveys of Cottonwood Canyon in 1998 to confirm experienced in the monitoring wells and to document areas of groundwater discharge. Gain/loss surveys were conducted throughout reach of Cottonwood Canyon from Mill Canyon in Section 2, Township 17 South, Range 6 East to below Roans Canyon in Section 24, Township 17 South, Range 6 East. Station selection was based upon areas of detected change and to duplicate previous research (USGS). As discussed earlier, data collected compared directly to the climatic trends and to the data collected by the USGS (refer to Attachment 5 for Gain/Loss Survey Data). Over a two year period (1998-2000), flow the Cottonwood Spring area ranged from approximately 100 gpm to 40 gpm. The discharge data collected by PacifiCorp from 1998-2000 from the Cottonwood Spring area compared directly to the data collected by the USGS during the late 70's and early 80's.

* Data from a study conducted by Mayo & Associates indicate that water from the alluvial system in Cottonwood Canyon is of modern age and is not related to the deep groundwater systems encountered in the mine.

* On October 27, 1998 the Division concluded the issue of Cottonwood Spring. As stated in the letter, "no definitive connection between Cottonwood Spring has been cited or proven in relation to mining at the Deer Creek Mine".

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# *VOLUME 9*
# *HYDROLOGIC SECTION*

## *Appendix C*

## Cottonwood Canyon Creek Hydrogeologic Investigation

## Attachment 1
## DOGM Correspondence

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Division Director

# State of Utah

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING

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Salt Lake City, Utah 84180-1203
801-538-5340

September 11, 1991

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TO: Pamela Grubaugh-Littig, Permit Supervisor

FROM: Ken Wyatt, Tom Munson, Reclamation Hydrologists

RE: Cottonwood Spring Citizen's Complaint, Deer Creek Mine, Pacificorp Electric Operations, ACT/015/018, Folder # 2 and Citizen's Complaint File, Emery County, Utah

## SYNOPSIS

On August 1, 1991, the Division received a letter from Mr. Jim Peacock stating that a spring located in Cottonwood Creek had ceased flowing over the last several years. He had heard about the increased flows from the Deer Creek Mine and requested the Division to investigate whether these increased flows from the mine had any relation to this spring. Mr. Peacock has water rights along Cottonwood Creek.

In response to the citizen complaint from Jim Peacock received by the Division on August 1, 1991, a meeting was held on August 20, in the Cottonwood Creek area. The following persons were in attendance.

| NAME | AGENCY/AFFILIATION | ADDRESS, PHONE # |
|---|---|---|
| Eugene Johansen | Cottonwood Creek Consolidated Irrigation Co. | Castledale |
| Jay Humphrey | Emery Water Conservancy District | Castledale |
| Rodger Fry | Pacificorp | SLC, 220-4610 |
| Chuck Semborski | Pacificorp | Huntington, 653-2312 |
| Carly Burton | Pacificorp | SLC, 220-2174 |
| Val Payne | Pacificorp | Huntington, 653-2312 |
| Denise Dragoo | Attorney for Pacificorp | 215 S. State, Suite 1200 SLC, 84111; 531-8900 |
| Ken Wyatt | Utah Div. Oil, Gas & Mining | SLC, 538-5266 |
| Tom Munson | Utah Div. Oil, Gas & Mining | SLC, 538-5288 |
| Bill Warmack | Utah Div. Water Rights | Price, 637-1303 |
| Jim Peacock | Ranch Owner | 150 E 7060 S, Midvale, 84047; 255-2221 |
| Paul Peacock | Ranch Operator | Orangeville |

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**ANALYSIS**

The meeting commenced at 11:00 a.m. at the junction of Straight Canyons and Cottonwood Canyons. Mr Jim Peacock began by describing his properties in the area, the history of these properties and the agricultural practices used on this land. The land being affected by the loss of this spring water is located in Section 7 and 8 of T18S R7E. (See attachment 1)

The tour then went up Cottonwood Canyon to the point of diversion from Cottonwood Creek. At this time approximately .23 CFS flow was observed entering this canal. (Approx. .25 feet in a 6" flume)

Following this observation, we visited the site of the spring. No water was observed in the creek channel or from the spring discharge pipe. The spring previously surfaced from the Northeast hillside slightly above creek level. Discussions were held concerning the flow of this spring. Eugene Johansen indicated that this spring has been diminishing for 8 - 10 years. U.S. Geological Survey records from 1977 - 1982 indicated that the spring flowed between 40 and 110 GPM continuously from the Blackhawk Formation. Cottonwood Creek between Mountain Coal Mine to the Spring was wet with very limited surface water.

The tour then proceeded to the culvert outlet at Mountain Coal Mine where it was observed that the majority of Cottonwood Creek flow was from the mine water discharge pipe below the sediment pond. The stream flow as measured at the USGS monitoring station was .32 CFS (.19 feet through a 12"flume).

Examination of map No.3 (partial copy as attachment 2) included in the Deer Creek Mine UPDES Permit Application shows that the area of major water production within the mine is located just south of the Roans Canyon Fault. The spring is located just south of the Roans Canyon Fault on the down-dipped side of the canyon near the axis of the Straight Canyon Syncline. The mine water discharge at the Deer Creek Mine averaged 6.75 CFS from December 1990, to July 1991.

Using water chemistry data from the Trail Mountain Mine 1986 water monitoring program, Stiff diagrams were generated for this spring and Cottonwood Creek. Pacificorp FAXed the Division data for two springs adjacent to the one in question that they monitored this year. Additionally, I plotted Stiff diagrams for some of the Deer Creek mine inflows and the adjacent springs in Cottonwood Creek. The Stiff diagrams are attached.

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Trail Mountain Mine

The Stiff diagrams did show that the spring water quality was very consistent throughout 1986. The diagrams can be superimposed over the others and they show very little difference. This indicates that the source of the water is groundwater from a formation and probably not from the alluvial stream channel. If it were the stream channel one would expect the diagrams to change over the year from periods of peak flow to base flow in late summer and fall.

After reviewing stiff diagrams, the mine permit application, flow records, and the geologic information presented in the PAP, it is possible that the Deer Creek Mine has intercepted significant groundwater quantities which may have caused the decreased flow at the spring. The last six years have been drought years which presents the possibility that the loss of this spring may have been drought related.

Other theories are that the spring flow originates from stream water present in the alluvial material in the canyon floor and that this water is surfacing at the spring site since the canyon narrows considerably in this area. Based on the conditions present there is insufficient evidence to indicate that the mine has intercepted the entire flow of this spring. More research would be required to collect additional information.

## RECOMMENDATION

The Division requested that Pacificorp revise their Probable Hydrologic Consequences (PHC) after the large amount of water was intercepted. This revised document was received on May 1, 1991 and is currently being reviewed. Information in the revised PHC may help answer some of these questions. Sufficient information is not available at this time to confirm or negate the impacts of the Deer Creek Mine on this spring and others. These questions will be addressed in the revised PHC review.

KW/jbe
ATCOTTSPR.MEM

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JUN 17

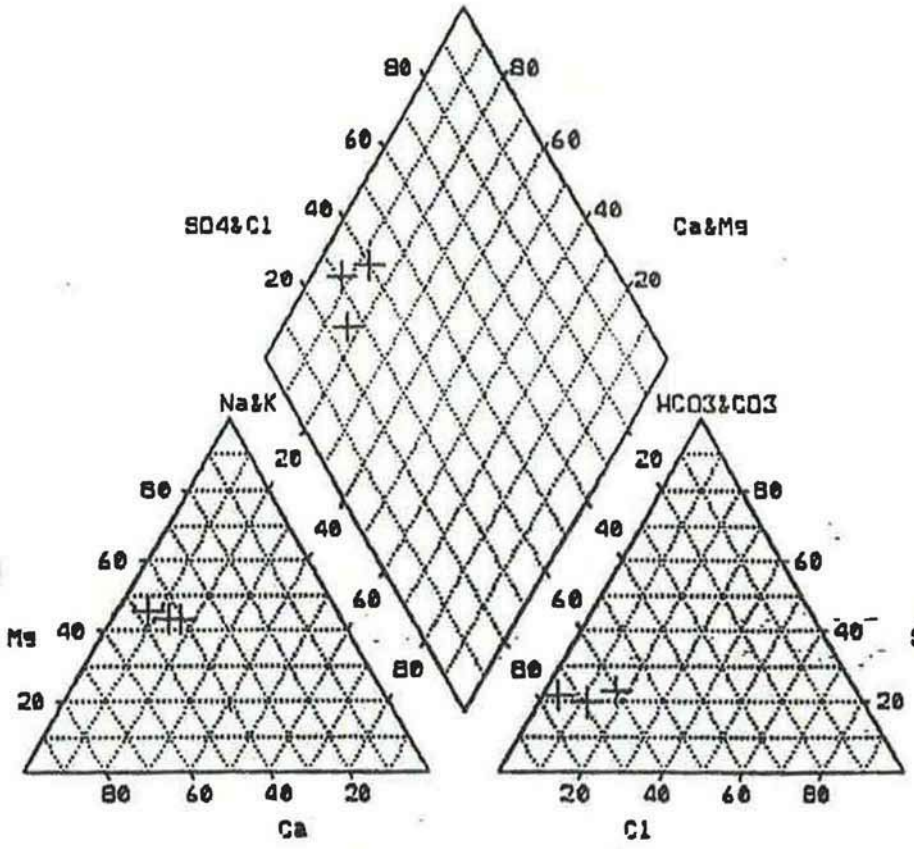
# HC - GRAM

HydroChemical Graphic Representation Analysis Methods

Version: HC-GRAM 1.42

20-Sep-1991 11:33:45.72

**Project: Cottonwood Canyons Springs**

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JUN 17

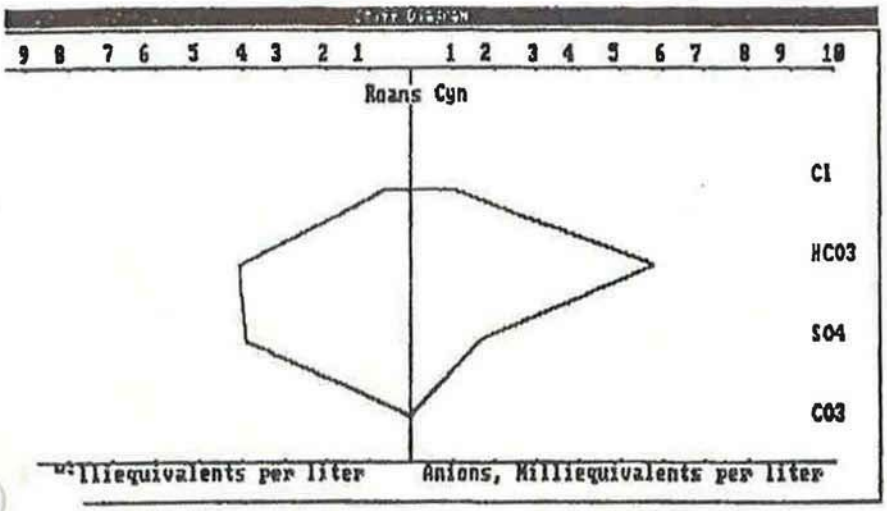
ep-1991 11:27:24.70

Chemical Constituents in ppm

| ample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5-22-91 | 81.90 | 47.90 | 14.22 | 1.79 | 355.00 | 0.00 | 80.00 | 35.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| ample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| is Cyn | 5-22-91 | 4.09 | 3.94 | 0.62 | 0.05 | 5.82 | 0.00 | 1.67 | 0.99 | 0.00 | 0.00 | 0.00 | 0.00 |

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# Report: Cottonwood Canyon Springs

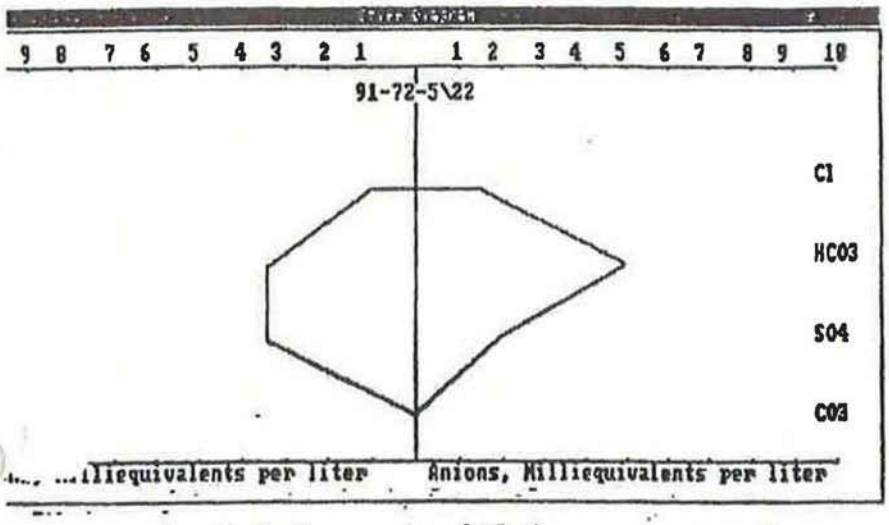
ep-1991 11:27:50.02

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 5-22-91 | 67.90 | 41.40 | 22.20 | 2.40 | 303.00 | 0.00 | 90.00 | 50.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-5\22 | 5-22-91 | 3.39 | 3.41 | 0.97 | 0.06 | 4.97 | 0.00 | 1.87 | 1.41 | 0.00 | 0.00 | 0.00 | 0.00 |

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STATE DIVISION OIL, GAS AND MINING

JUN 17 1

Report: Cottonwood Canyon Springs

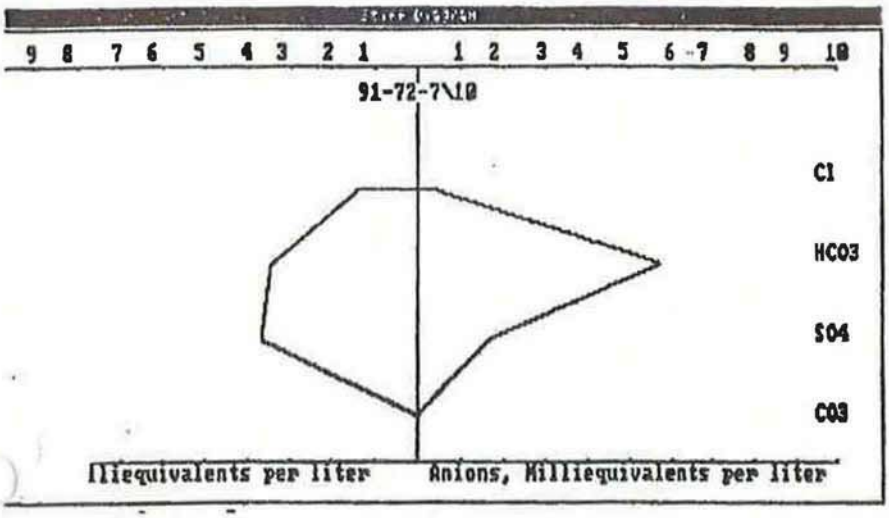
Sep-1991 11:28:15.29

Chemical Constituents in ppm

| ple | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| .. .. | 7-10-91 | 69.10 | 44.60 | 31.40 | 0.66 | 351.00 | 0.00 | 80.00 | 10.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-7\10 | 7-10-91 | 3.45 | 3.67 | 1.37 | 0.02 | 5.75 | 0.00 | 1.67 | 0.28 | 0.00 | 0.00 | 0.00 | 0.00 |

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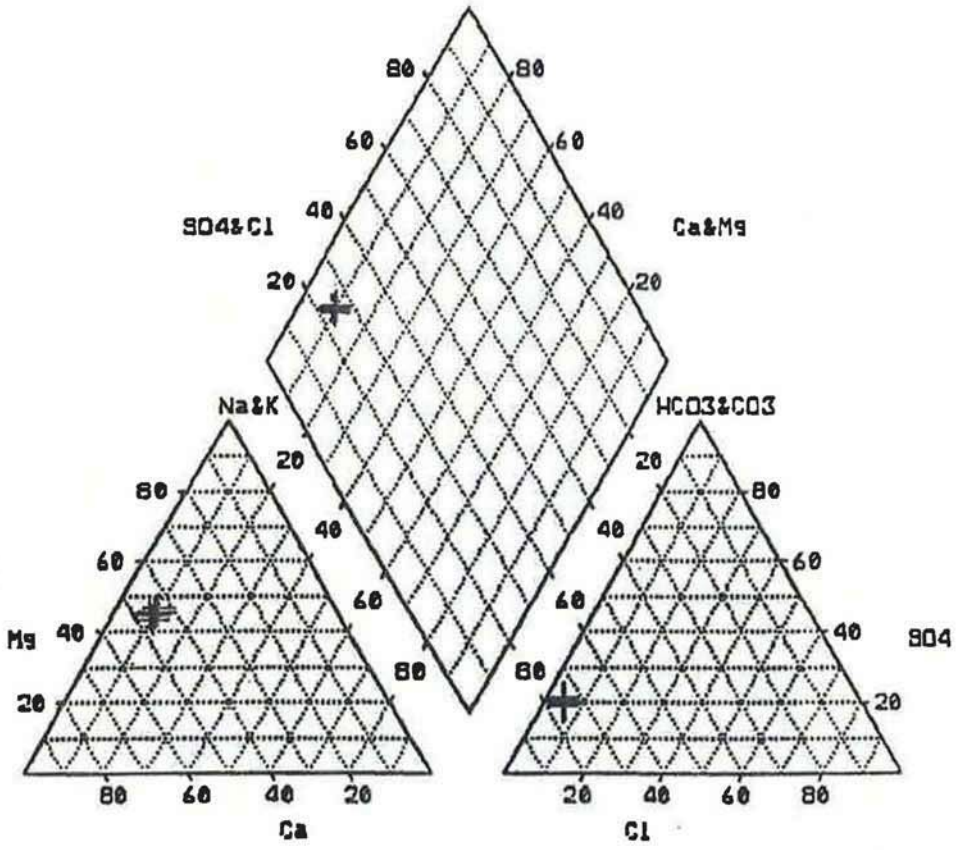
# HC - GRAM

HydroChemical Graphic Representation Analysis Methods

Version: HC-GRAM 1.42

23-Sep-1991 11:37:46.02

**Project: Cottonwood Spring Water Quality**

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JUN 17

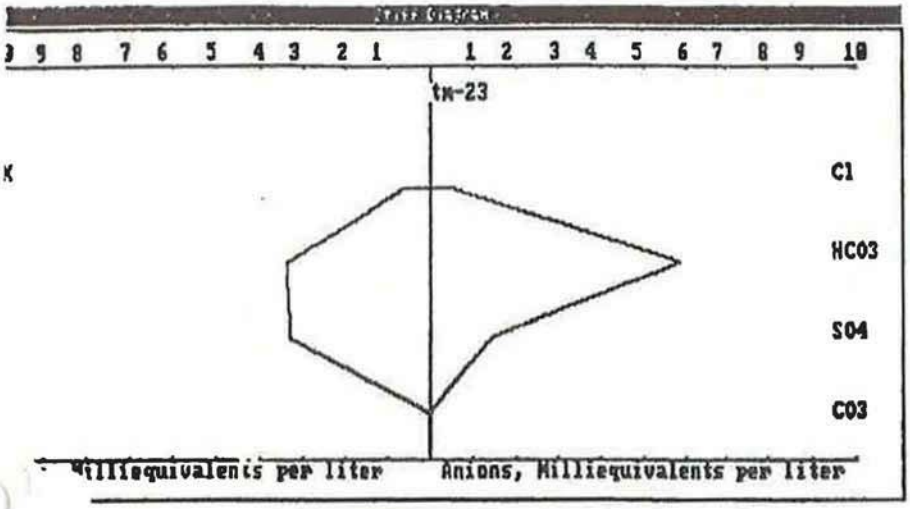
Sep-1991 10:34:01.83

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9-30-86 | 68.00 | 40.00 | 14.00 | 2.00 | 359.00 | 0.00 | 70.00 | 14.80 | 0.00 | 0.00 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 9-30-86 | 3.39 | 3.29 | 0.61 | 0.05 | 5.88 | 0.00 | 1.46 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 |

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# Report: Cottonwood Spring Water Quality

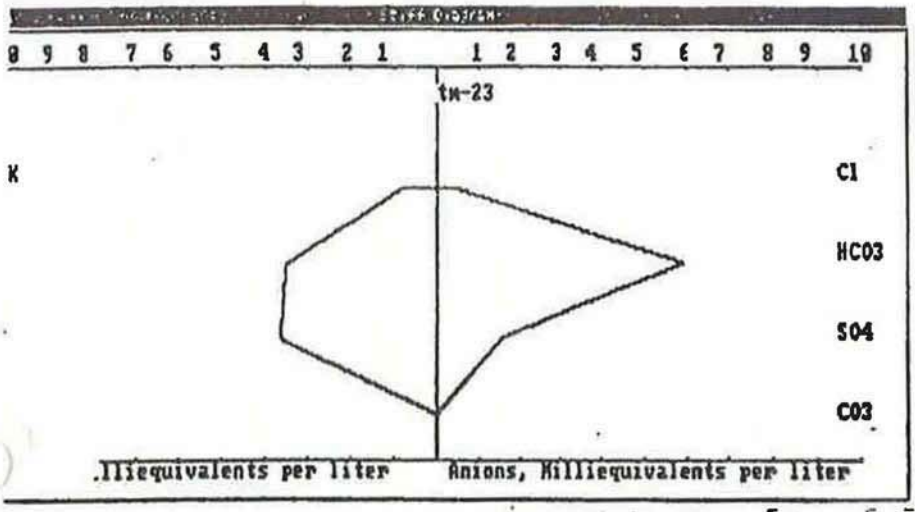
Sep-1991 10:34:27.15

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | 2-28-86 | 70.00 | 44.00 | 18.00 | 2.00 | 362.00 | 0.00 | 75.00 | 13.00 | 0.20 | 0.03 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 2-28-86 | 3.49 | 3.62 | 0.78 | 0.05 | 5.93 | 0.00 | 1.56 | 0.37 | 0.00 | 0.00 | 0.00 | 0.00 |

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JUN 17 1993
Utah Division Oil, Gas & Mining

# Report: Cottonwood Spring Water Quality

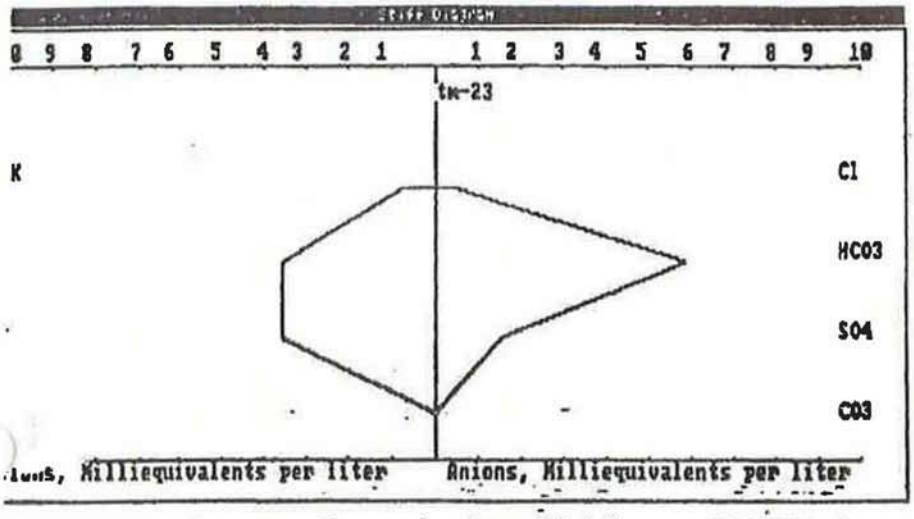
Sep-1991 10:34:52.47

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 3-13-86 | 72.00 | 43.00 | 17.00 | 2.00 | 361.00 | 0.00 | 75.00 | 13.00 | 0.22 | 0.06 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 3-13-86 | 3.59 | 3.54 | 0.74 | 0.05 | 5.92 | 0.00 | 1.56 | 0.37 | 0.00 | 0.00 | 0.00 | 0.00 |





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JUN 17

# Report: Cottonwood Spring Water Quality

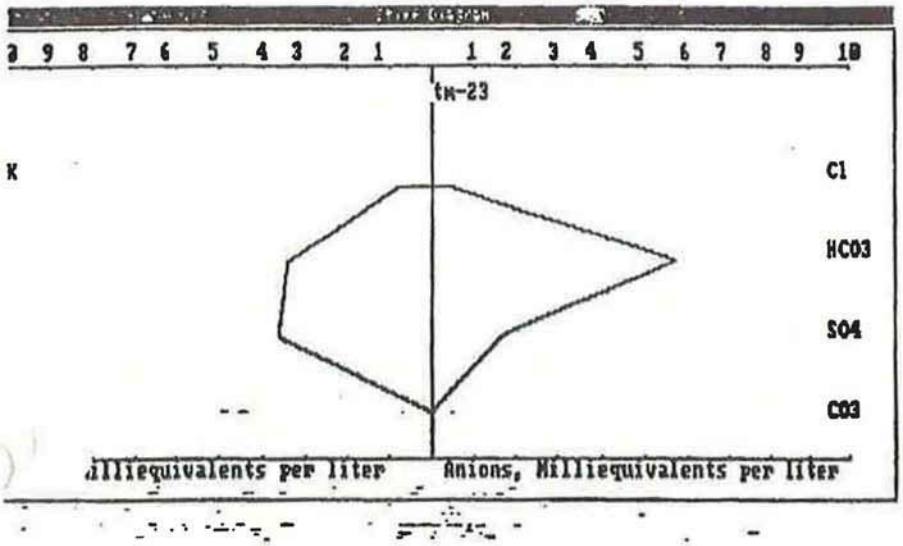
Sep-1991 10:35:17.74

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 4-7-86 | 68.00 | 44.00 | 17.00 | 2.00 | 351.00 | 0.00 | 80.00 | 12.00 | 0.25 | 0.06 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 4-7-86 | 3.39 | 3.62 | 0.74 | 0.05 | 5.75 | 0.00 | 1.67 | 0.34 | 0.00 | 0.00 | 0.00 | 0.00 |

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# Report: Cottonwood Spring Water Quality

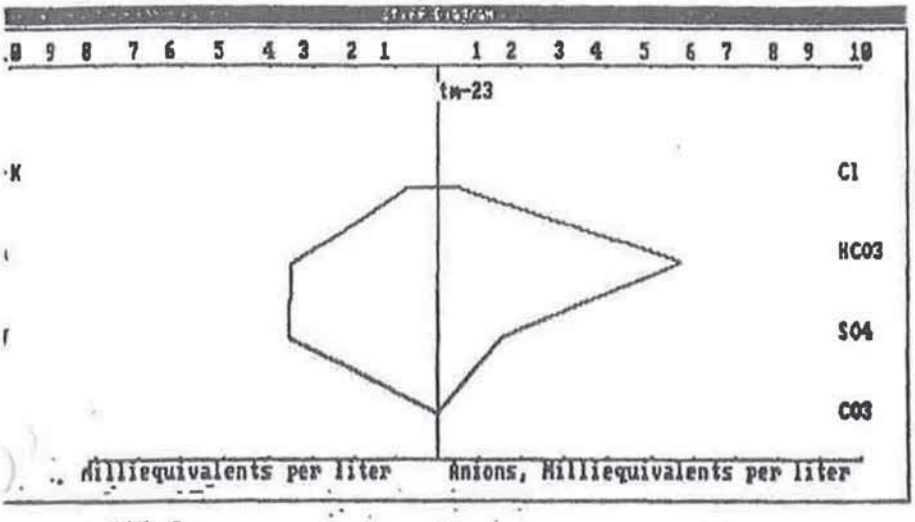
-Sep-1991 10:35:43.06

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 5-5-86 | 70.00 | 43.00 | 16.00 | 2.00 | 350.00 | 0.00 | 75.00 | 14.00 | 0.25 | 0.02 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 5-5-86 | 3.49 | 3.54 | 0.70 | 0.05 | 5.74 | 0.00 | 1.56 | 0.39 | 0.00 | 0.00 | 0.00 | 0.00 |

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# Report: Cottonwood Spring Water Quality

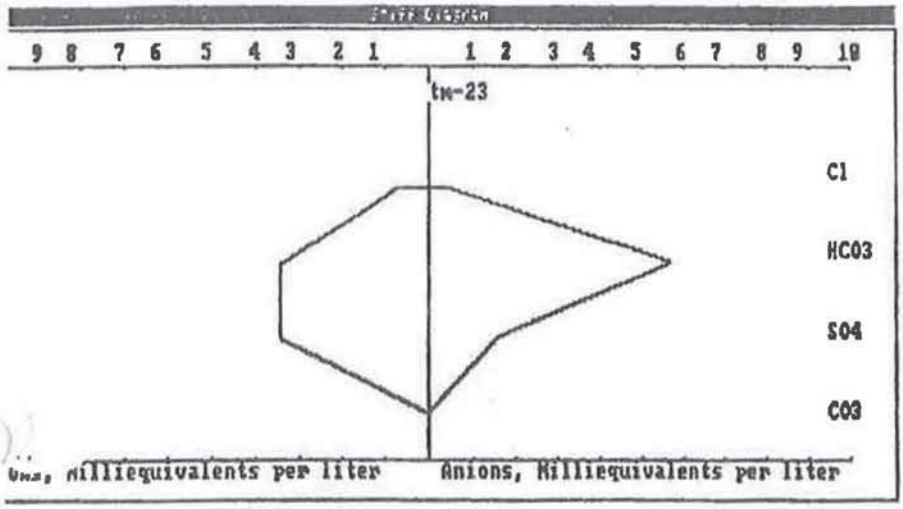
Sep-1991 10:36:08.38

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 6-30-86 | 68.00 | 42.00 | 16.00 | 2.00 | 348.00 | 0.00 | 75.00 | 12.00 | 0.44 | 0.07 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 6-30-86 | 3.39 | 3.45 | 0.70 | 0.05 | 5.70 | 0.00 | 1.56 | 0.34 | 0.01 | 0.00 | 0.00 | 0.00 |

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# Report: Cottonwood Spring Water Quality

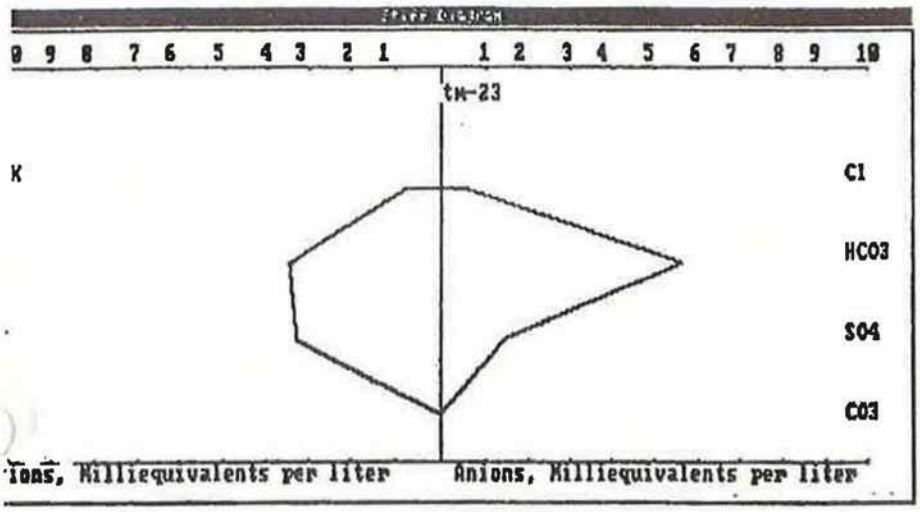
Sep-1991 10:36:33.70

Chemical Constituents in ppm

| | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 7-30-86 | 70.00 | 40.00 | 16.00 | 3.00 | 345.00 | 0.00 | 70.00 | 15.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tm-23 | 7-30-86 | 3.49 | 3.29 | 0.70 | 0.08 | 5.65 | 0.00 | 1.46 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 |





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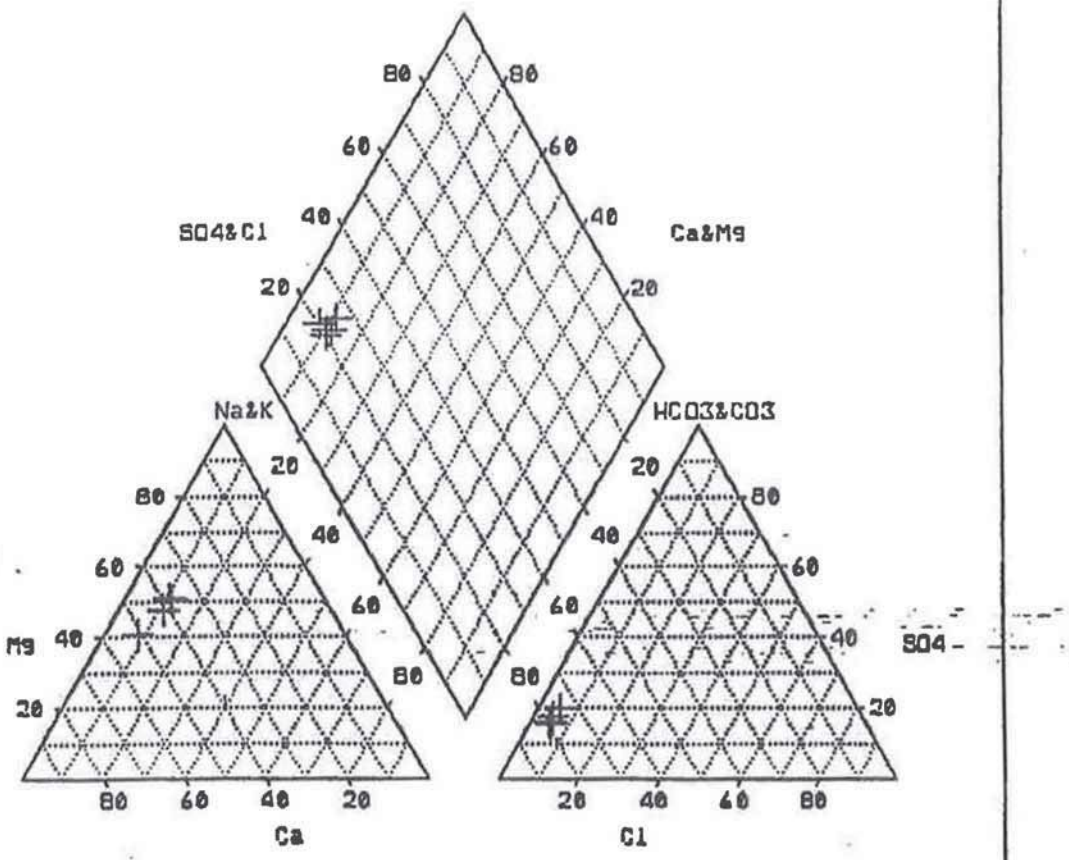
# HC - GRAM

HydroChemical Graphic Representation Analysis Methods

Version: HC-GRAM 1.42

25-Sep-1991 12:03:32.12

**Project: Cottonwood Creek Water Quality**

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JUN 17 1

Report: Cottonwood Creek Water Quality

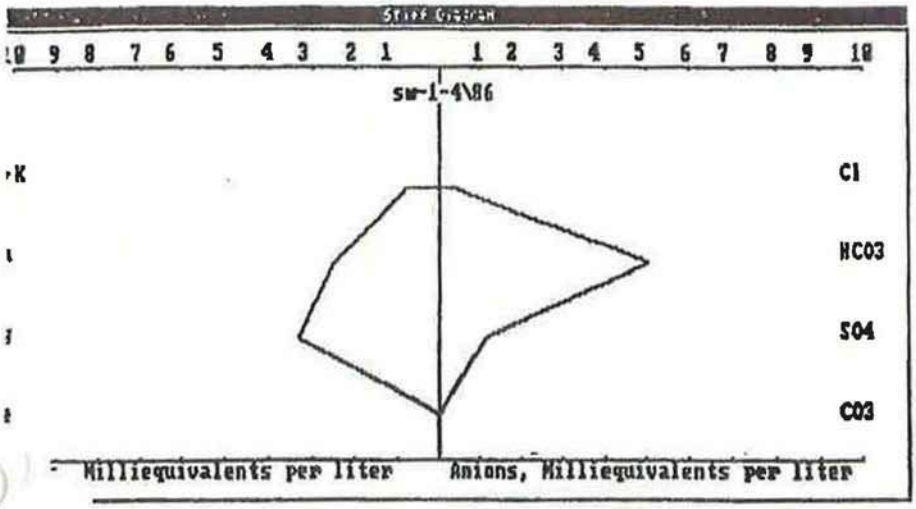
-Sep-1991 11:09:38.32

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4-7-86 | 50.00 | 40.00 | 17.00 | 2.00 | 310.00 | 0.00 | 56.00 | 11.00 | 0.25 | 0.04 | 0.00 | 0.08 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sw-1-4\86 | 4-7-86 | 2.49 | 3.29 | 0.74 | 0.05 | 5.08 | 0.00 | 1.17 | 0.31 | 0.00 | 0.00 | 0.00 | 0.00 |

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# Report: Cottonwood Creek Water Quality

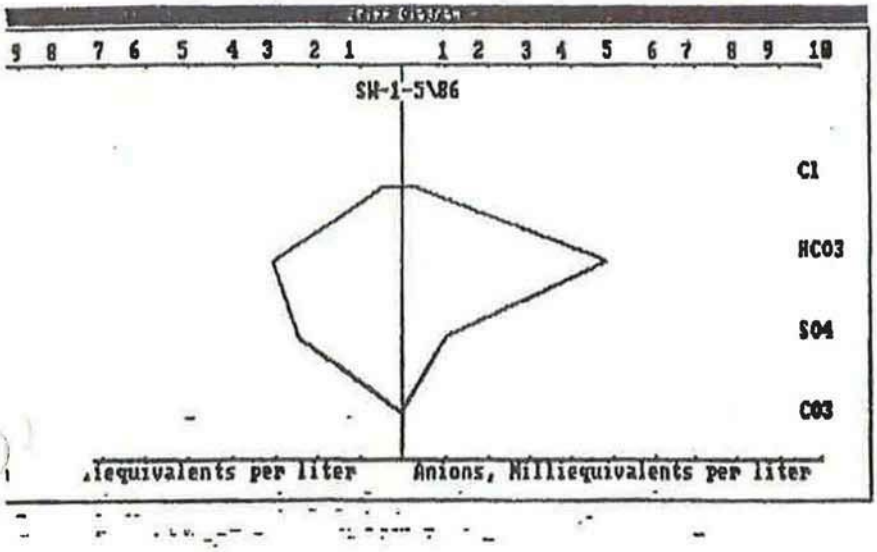
ep-1991 11:10:03.64

Chemical Constituents in ppm

| ample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -5\86 | 5-5-86 | 62.00 | 30.00 | 11.00 | 1.00 | 295.00 | 0.00 | 48.00 | 9.00 | 0.22 | 0.06 | 0.00 | 0.28 |

Chemical Constituents in Equivalents per Million

| ample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -5\86 | 5-5-86 | 3.09 | 2.47 | 0.48 | 0.03 | 4.84 | 0.00 | 1.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.01 |

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# Report: Cottonwood Creek Water Quality

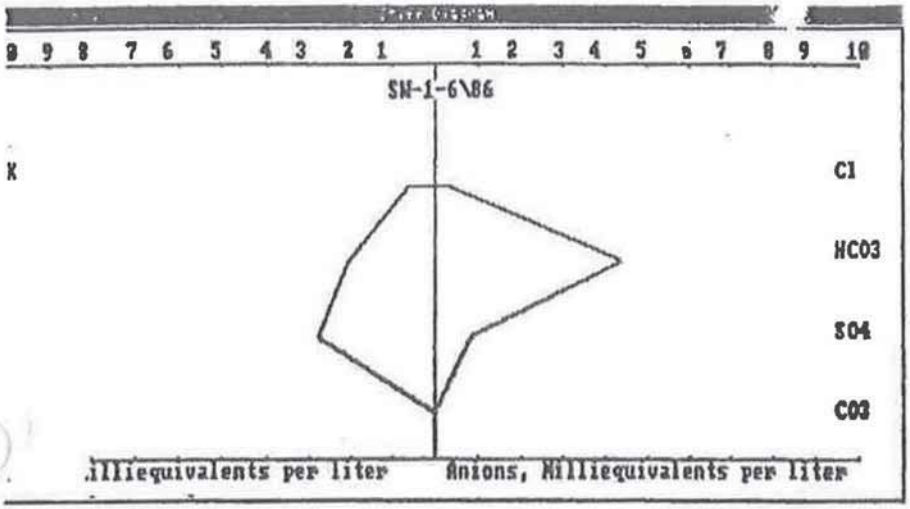
Sep-1991 11:10:28.96

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW-1-6\86 | 5-30-86 | 42.00 | 34.00 | 13.00 | 2.00 | 267.00 | 0.00 | 40.00 | 10.00 | 0.25 | 0.08 | 0.00 | 0.15 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW-1-6\86 | 6-30-86 | 2.10 | 2.80 | 0.57 | 0.05 | 4.38 | 0.00 | 0.83 | 0.28 | 0.00 | 0.00 | 0.00 | 0.01 |

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Report: Cottonwood Creek Water Quality

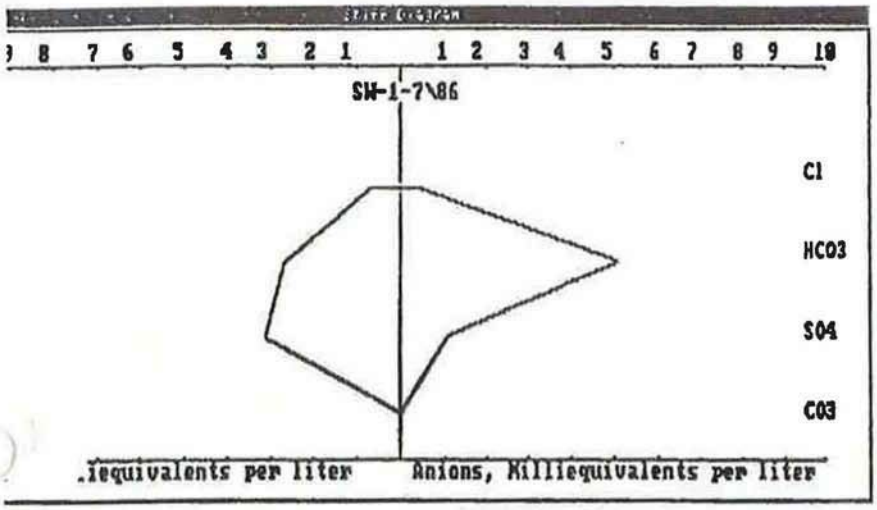
p-1991 11:10:54.23

Chemical Constituents in ppm

| ple | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| \oo | 7-30-86 | 54.00 | 38.00 | 14.00 | 4.00 | 312.00 | 0.00 | 50.00 | 12.00 | 0.00 | 0.00 | 0.00 | 0.20 |

Chemical Constituents in Equivalents per Million

| mple | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7\86 | 7-30-86 | 2.69 | 3.13 | 0.61 | 0.10 | 5.11 | 0.00 | 1.04 | 0.34 | 0.00 | 0.00 | 0.00 | 0.01 |

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Div. of Oil, Gas & Mining

JUN 17

# Report: Cottonwood Creek Water Quality

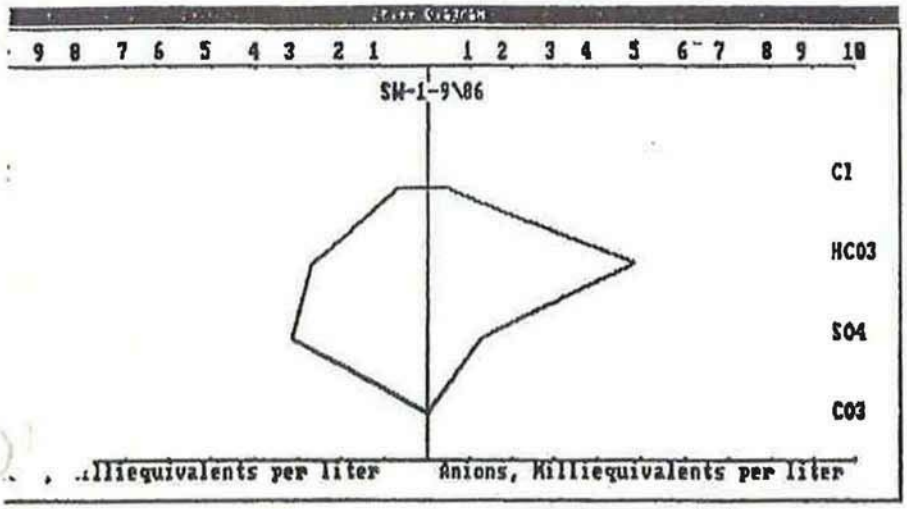
Sep-1991 11:11:19.55

Chemical Constituents in ppm

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW-1-9\86 | 9-29-86 | 54.00 | 38.00 | 13.00 | 7.00 | 298.00 | 0.00 | 62.00 | 13.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Chemical Constituents in Equivalents per Million

| Sample | Date | Ca | Mg | Na | K | HCO3 | CO3 | SO4 | Cl | NO3 | PO4 | Si | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW-1-9\86 | 9-29-86 | 2.69 | 3.13 | 0.57 | 0.18 | 4.88 | 0.00 | 1.29 | 0.37 | 0.00 | 0.00 | 0.00 | 0.00 |

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FEB 02 2015
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State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING

1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, Utah 84114-5801
801-538-5340
801-359-3940 (Fax)
801-538-7223 (TDD)

Michael O. Leavitt
Governor

Lowell P. Braxton
Division Director

October 27, 1998

Alan Rabinoff, Group Leader
Bureau of Land Management
324 South State Street
Salt Lake City, Utah 84145-0155

Dear Mr. Rabinoff:

Enclosed are copies of memos to our files regarding the Cottonwood Spring citizen's complaint filed in 1991 by Mr. Jim Peacock. The Division has made an extensive review of this issue and has made findings to conclude the complaint.

By this letter and enclosed memos, the Division also concludes the issue of Cottonwood Spring. To date, no definitive connection between Cottonwood Spring has been cited or proven in relation to mining at the Deer Creek Mine. Hopefully, this documentation from our division will provide the needed paperwork for the US Forest Service and the Bureau of Land Management to move forward with the lease relinquishment for this area.

Please contact me at 801-538-5306 if I may be of further assistance.

Sincerely,

Mary Ann Wright
Associate Director, Mining

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lam
Enclosure
cc: Chuck Semborski, Energy West, w/o
Blake Webster, PacifiCorp, w/o
O:\015018.DER\FINAL\KAISER.RAB

United States Department of Agriculture | Forest Service | Manti- La Sal National Forest | Supervisor's Office
599 West Price River Drive
Price UT 84501
Phone # (435) 637-2817
Fax # (435) 637-4940

File Code: 2820-4

Date: May 5, 1999

COP

UTAH DIVISION OIL, GAS AND MINING

Mary Ann Wright
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

Dear Mary Ann:

This letter is in regard to the Cottonwood Spring and associated lease relinquishment issue on the Manti-La Sal National Forest (MLS). Your letter dated October 27, 1998 relates that the Division of Oil, Gas and Mining (DOGM) has concluded the issue of the spring stating that "...no definitive connection between Cottonwood Spring has been cited or proven in relation to mining at the Deer Creek Mine". The letter included documentation intended to aid us in resolving the Cottonwood Spring/Creek issue. However, we find that the information provided makes a compelling case for a connection between mining activities and loss of water at the spring. Specifically, in our review, the DOGM analysis (Cottonwood Spring Chronology and Information Related to Roans Canyon Graben Crossing, October 16, 1998) finds:

- That known information (at the time of the report) about the alluvial system of the area suggests that it is incapable of delivering the quantities of water which were once observed in flow at Cottonwood Spring.

- That known information suggests the Roans Canyon Graben and fracture system are capable of containing and transmitting sufficient quantities of water to supply observed spring flows and are geologically associated with Cottonwood Spring and Creek.

- That consistency of Stiff diagrams from Cottonwood Spring and Creek indicate a groundwater rather than alluvial source.

- That Stiff diagrams from Cottonwood Spring and Creek exhibit the same basic water chemistry as flow from a drill hole used to dewater the graben, suggesting they may be the same water.

- That mining operations utilizing drill holes in attempts to dewater the graben coincide with loss of flow at Cottonwood Spring and Cottonwood Creek.

Based on this body of evidence and particularly the coincidence of dewatering actions with loss of flow, the MLS believes that there are still valid questions remaining with respect to this issue.

Subsequent to DOGM's analysis, Energy West Mining (Energy West) retained Mayo and Associates (Mayo) to perform a hydrologic evaluation of Cottonwood Spring. At a December 18, 1998 meeting, Mayo presented findings that Cottonwood Spring is supported by a gravel lens in the alluvial deposits which receives recharge from surface flow in Cottonwood (Canyon) Creek. It is their theory that water that once emerged from Cottonwood Spring now emerges elsewhere

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in the drainage, although an exact location is undefinable. The point where the gravel lens is recharged is similarly not defined. Mayo also indicated that the base flow component of the historic spring may have come from older sources, however, the missing link is the radiocarbon age of water at the spring.

According to Energy West, 1998 was the first year that there was perennial flow in Cottonwood Creek above Roans Canyon since Cottonwood Spring ceased flowing in 1989. The MLS understands from historical reports, from longtime local residents, and from studies done by the USGS and engineering firms, that Cottonwood Creek was perennial starting at the location of Cottonwood Spring. It was reported that there was never cessation of flow during the drought periods of the 1930's and 1950's. There has been an apparent loss of perennial conditions in the creek between Cottonwood Spring and Roans Canyon that coincides with the cessation of flow at Cottonwood Spring. Mayo also performed a gain/loss study on the creek in 1998 and ascertained that essentially the same quantity of water emits from the drainage now as did in 1979 (based on a USGS study). However, it is not known if perennial flow in the creek below Cottonwood Spring will continue or if year-round flow in 1998 resulted from above average annual precipitation, as no correlation to 1979 climatic conditions were made.

The MLS believes that loss of water from Cottonwood Spring and Creek would indeed constitute a material damage to National Forest resources, due to impacts to wildlife and macroinvertebrate species, if mining were the causal factor. In such a case, this would necessitate water replacement/mitigation required by the mine plan and the stipulations contained in federal leases associated with the Deer Creek and Cottonwood Mines. The standard of proof is at issue. DOGM's analysis theorizes a connection of flow loss to mining operations while Mayo presents a dissenting theory that there is no connection and that perennial flow returned in 1998. Mayo's theory seems plausible but we believe it is essential that monitoring be continued to either validate or discount it, and to learn whether the effect on surface resources has been temporary or permanent.

While year-round flow was documented in 1998, the MLS is concerned that because of the high water year in 1998, these conditions may not be repeated in 1999 or subsequent years. The true test to discern if perennial conditions return to the creek and further validate that the same quantity of water circulates in the drainage, will be to continue observing the creek. Further, without perennial flow in the creek, the recharge source for any gravel lens may be absent. Therefore, the MLS believes that the flow monitoring and gain/loss flow study, as defined by Mayo, need to be continued for two additional years on Cottonwood Creek, with the data collected keyed to climatic conditions.

The MLS understands the need to resolve the Cottonwood Spring/Creek issue so the lease relinquishment process can continue, and we are committed to work with all affected parties to accomplish this task. However, the MLS cannot agree to lease relinquishment until the Cottonwood Spring/loss of water issue is resolved to our satisfaction. At a minimum Energy West must continue monitoring for two additional years as noted above. Additionally, we have identified a variety of alternative means to resolve the issue as follows:

A. Energy West can elect to wait until the additional two years of monitoring is completed. If the monitoring data and gain/loss study continue to indicate that Cottonwood Creek performs similar to the 1979 USGS Study, after adjusting for climatic conditions, and that perennial flow has been restored to Cottonwood Creek, we would agree that the

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Cottonwood Spring/Creek issue has been resolved. If the data indicate that perennial flow has not been restored, Energy West would then be required to pursue either Alternative B or C as outlined below. or

B. Restore perennial flow of like quantity and quality at or above Cottonwood Spring through artificial means, as specified in the lease stipulation. The MLS does not know how this might be accomplished, but we invite Energy West proposals for compliance with the lease stipulation. Any proposal will be subject to our approval and implementation would be Energy West's responsibility. We would then agree that the Cottonwood Spring/Creek issue has been resolved. or

C. Finance manipulation of existing watershed conditions to increase water yield and water quality sufficiently to offset impacts to wildlife and macroinvertebrate species resulting from loss of flow at Cottonwood Spring. Within the watershed, the Forest has identified approximately 660 acres of conifer encroached aspen stands that could be regenerated to increase flow as well as headcut stabilization and wetland enhancement work that would improve downstream water quality and timing of flow. These projects are outlined in greater detail in the attachment. Cost estimates have been made for planning, implementation, and monitoring of these projects which total $110,670. These estimates are coarse and actual costs could be more or less. The Forest is prepared to accept this estimated amount if Energy West prefers this alternative. We would agree that the Cottonwood Spring/Creek issue has been resolved once funds are received for the identified mitigation work.

Our preference is Alternative A as we believe this is the fairest approach, testing the Energy West/Mayo theory prior to any additional funding or resource commitments that may prove unnecessary. The other alternatives however do present the opportunity for more rapid resolution of the Cottonwood Spring/Creek issue, leading to an earlier lease relinquishment which Energy West may find preferable.

I believe this provides tangible solutions to resolve to the spring issue and allow the relinquishment process to continue. We appreciate your continued cooperation on this matter. If you have any questions, please contact me or Aaron Howe at (435) 637-2817.

Sincerely,

for
JANETTE S. KAISER
Forest Supervisor

cc:
BLM, Utah State Office

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## Mitigation Projects for Water Loss at Cottonwood Spring

The projects outlined below have been designed to mitigate the loss of water from Cottonwood Spring. These projects are all located within the Cottonwood Creek drainage and have the goals of improving water yield, timing of flow, and aquatic macroinvertebrate habitat. Burning decadent aspen stands where conifer encroachment is occurring is expected to increase water yield. Headcut stabilization is expected to improve water quality which would positively effect macroinvertebrate habitat. Headwater riparian and wetland enhancement would potentially extend the perennial flow period downstream in Cottonwood Creek which would also positively effect macroinvertebrate habitat.

### I. Environmental Assessment

Conducting an Environmental Assessment, in compliance with the National Environmental Policy Act (NEPA) would be part of the overall mitigation project costs. This process involves further field investigations and collaborative input from experts in the areas of wildlife biology, vegetation management, botany, hydrology, soils, engineering, fuels, and archeology. The NEPA process would also require public review and input prior to implementation of the project.

Environmental Assessment for Mitigation Projects: **$15,000**

### II. Aspen Regeneration

This project is intended to mitigate the loss of water from Cottonwood Springs by increasing water yield within the drainage. Recent research has shown, when successional trends occur from aspen to mixed conifer, water yield is significantly reduced (Gifford, Humphries, and Jaynes, 1984). By conservative estimates, water yield would increase by 250 acre-feet per year, per 1000 acres of converted stands (Bartos and Campbell, 1998). This conversion factor was applied to the total treatment area of this project proposal (660 acres) and water yield is expected to increase by approximately 165 acre-feet per year (or 100 gallons per min).

Many aspen stands are present in west side tributaries to Cottonwood Canyon. Conifer encroachment is occurring and existing aspen stands are decadent. The areas proposed for treatment are approximately 40 to 100 acres in size, with some isolated treatment areas and other connected areas. The goals would be to increase aspen vigor, improve ground cover, improve soil moisture retention, and increase water yield. The treatment would consist of burning aspen to stimulate regeneration and remove encroaching conifers. Some steep slopes occur in the project area and mechanical pretreatment or hand slashing may be required before burning. Monitoring of plots within the treatment area will be established prior to treatment then reanalyzed every year for three years to demonstrate if desired effects of aspen regeneration have occurred. A report and display of data will be required at the end of the monitoring period.

| Implementation Costs: (*includes project layout and pretreatment ($44.00 per acre)* | | |
|---|---|---|
| Trail Canyon . | 150 acres | $ 6,600 |
| Indian Lodge Canyon | 100 acres | $ 4,400 |
| Unnamed | 110 acres | $ 4,800 |
| Dairy Canyon | 180 acres | $ 7,900 |
| Winks Canyon | 120 acres | $ 5,300 |
| Total acres = 660 acres | | |
| Monitoring ($1,000 per year) | | $ 3,000 |
| | | **Project Total $32,000** |

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**III. Headcut Stabilization**

Headcutting is actively occurring in the headwaters of Roans Canyon and an unnamed tributary to the North of Roans Canyon. This project will not likely effect water quantity or timing of stream flows but will likely improve water quality. The project involves a combination of hard structures mechanically placed in gullies, mechanically reshaping, and revegetation with protection from livestock grazing. Heavy equipment such as an excavator will be required to complete the project.

| | | |
|---|---|---|
| Project Design and Layout | | $ 2,000 |
| Roans Canyon headcuts | 5 acres | $ 3,500 |
| Unnamed Canyon headcuts | 3 acres | $ 2,500 |
| Revegetation | 8 acres | $ 2,000 |
| Treatment area protection (fencing for 8 acres) | | $ 2,000 |
| Monitoring | | $ 1,000 |
| | **Project Total** | **$13,000** |

**IV. Wetland and Riparian Enhancement**

The upper segment of Cottonwood Canyon is much broader than the lower reaches and is meadow-like with some isolated willow stands along the stream. Just downstream from this meadow reach, Cottonwood Canyon is steepiy incised with erodible banks and narrow riparian areas. The proposed project would consist of building a series of small earthen check dams in the lower meadow reach to prevent further upstream migration of channel erosion. The desired effect would be expansion of wetland and riparian areas upstream of the dams. The objective would be to increase retention of water in the headwaters of Cottonwood Creek so that perennial flow could be sustained later into the season.

| | | |
|---|---|---|
| Project Design and Layout | | $ 2,000 |
| Equipment time (includes hauling and material placement) | | $ 5,000 |
| Fill Material | | $ 3,000 |
| Fencing (Materials and Labor) | 5 acres | $12,000 |
| Monitoring | | $ 1,000 |
| | **Project Total** | **$23,000** |

---

**Summary of All Mitigation Costs**

| | | |
|---|---|---|
| **I. Environmental Assessment** | $ 15,000 | |
| **II. Aspen Regeneration** | $ 32,000 | |
| **III. Headcut Stabilization** | $ 13,000 | |
| **IV. Wetland and Riparian Enhancement** | $ 23,000 | |
| **Total** | $ 83,000 | |
| **Overhead (25% of total mitigation costs)** | $ 27,670 | |
| **Total Mitigation Costs** | **$110,670** | |

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**References**

Bartos, D. L., and R. B. Campbell.- Water depletion and other ecosystem values forfeited when conifer forests displace aspen communities. Rangeland Management and Water Resources, American Water Resources Association. May 1998.

Gifford, G. F., W. Humphries, and R. A. Jaynes. A preliminary quantification of the impacts of aspen to conifer succession on water yield - II. Modeling Results. Water Resources Bulletin, American Water Resources Association. April 1984.

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Div. of Oil, Gas & Mining

State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL, GAS AND MINING

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November 1, 1999

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DIVISION OIL, GAS AND MINING

Janette Kaiser, Forest Supervisor
US Forest Service
599 West Price River Drive
Price, Utah 84501

Re: Cottonwood Spring, PacifiCorp, Deer Creek Mine, ACT/015/018, File #3, Emery County, Utah

Dear Ms. Kaiser:

This letter is in response to your May 17, 1999 letter to me regarding Cottonwood Spring. This site has been the subject of numerous discussions and field visits by many of our respective personnel. I am writing this letter to clarify a basic issue.

Foremost, the division's analysis could not make a conclusive finding concerning the potential impact of mining on Cottonwood Spring flow. A Division hydrologist was allowed a time period of about four months in 1998 to further research and review data for this site in order to prove or disprove the allegation of a connection between spring flow and mining. The work began with the premise that there was a connection between mining/ dewatering at the Deer Creek Mine and spring flow reduction.

After a critical review of amassed data and analysis as detailed in the October 16, 1998 technical memo, and after lengthy discussions among technical personnel from the BLM and the Coal Program, it was concluded by OGM management that:

1. The existing data does not support that mining and the spring are linked as a cause and effect action, and,

2. That data cannot be obtained to support a link to mining. DOGM personnel concluded at a meeting with BLM that while more data could be collected concerning the issue, the information required to prove the case of a connection between mining and the spring could not be assembled. Thus, as you iterate in page one of your May 17, 1999 letter, DOGM believes that the best that can be done is to "suggest" and "indicate" certain technical items regarding alluvial systems, Roans Canyon Graben and Stiff diagrams.

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Manti-LaSal (MLS) National Forest is concerned about flow at the spring and has proposed to DOGM mitigation measures in the May 17, 1999 letter. However, in order for the Division to consider implementing your proposed mitigation measures, the MLS must present a more convincing technical case than that which we have already reviewed in our own memo.

Thank you for your comments on this matter. They have been reviewed and considered.

Sincerely,

Mary Ann Wright
Associate Director, Mining

cc: Richard Manus, BLM
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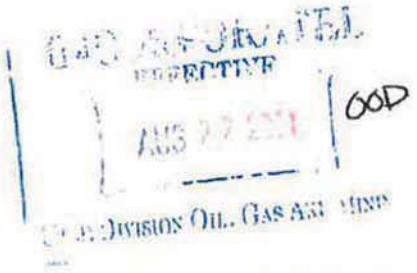
# *VOLUME 9*
# *HYDROLOGIC SECTION*

## *Appendix C*

## Cottonwood Canyon Creek Hydrogeologic Investigation

## Attachment 2
## USGS Flume Data

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UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - UTAH DISTRICT 09/13/91

STATION NUMBER 09324200 CTYWD C AB STRAIGHT CANYON NR ORANGEVILLE, UT STREAM SOURCE AGENCY USGS
LATITUDE 391826 LONGITUDE 1111102 DRAINAGE AREA 21.90 DATUM STATE 49 COUNTY 015

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1977 TO SEPTEMBER 1978
MEAN VALUES

| DAY | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .37 | .41 | .44 | .24 | .26 | .32 | .64 | .64 | 4.3 | .97 | .29 | .17 |
| 2 | .41 | .44 | .49 | .24 | .27 | .32 | .62 | .56 | 3.8 | .90 | .26 | .17 |
| 3 | .44 | .44 | .44 | .24 | .29 | .32 | .59 | .56 | 3.4 | .81 | .24 | .17 |
| 4 | .44 | .44 | .44 | .24 | .30 | .32 | .59 | .56 | 3.1 | .78 | .24 | .17 |
| 5 | .41 | .44 | .41 | .24 | .30 | .32 | .59 | .54 | 3.0 | .73 | .24 | .15 |
| 6 | .41 | .44 | .41 | .26 | .30 | .34 | .59 | .56 | 2.8 | .70 | .24 | .14 |
| 7 | .41 | .44 | .44 | .28 | .30 | .36 | .58 | .56 | 2.7 | .62 | .22 | .17 |
| 8 | .41 | .37 | .32 | .28 | .30 | .38 | .56 | .51 | 2.8 | .56 | .22 | .17 |
| 9 | .41 | .41 | .24 | .28 | .30 | .40 | .58 | .56 | 2.8 | .51 | .22 | .17 |
| 10 | .46 | .46 | .22 | .28 | .30 | .40 | .56 | .56 | 2.8 | .49 | .22 | .17 |
| 11 | .44 | .46 | .30 | .25 | .30 | .40 | .56 | .51 | 2.7 | .49 | .24 | .19 |
| 12 | .41 | .44 | .37 | .25 | .30 | .40 | .56 | .51 | 2.5 | .41 | .30 | .19 |
| 13 | .41 | .41 | .39 | .25 | .30 | .40 | .59 | .49 | 2.4 | .39 | .35 | .20 |
| 14 | .41 | .44 | .41 | .25 | .30 | .40 | .56 | .51 | 2.4 | .35 | .28 | .23 |
| 15 | .41 | .41 | .44 | .25 | .30 | .40 | .49 | .51 | 2.3 | .37 | .26 | .22 |
| 16 | .41 | .41 | .35 | .25 | .28 | .41 | .49 | .49 | 2.1 | .37 | .24 | .20 |
| 17 | .41 | .41 | .29 | .25 | .27 | .43 | .46 | .67 | 2.1 | .37 | .24 | .19 |
| 18 | .41 | .41 | .28 | .25 | .27 | .45 | .51 | .73 | 2.0 | .44 | .24 | .19 |
| 19 | .41 | .41 | .24 | .25 | .27 | .48 | .56 | .73 | 1.9 | .39 | .24 | .20 |
| 20 | .41 | .32 | .22 | .25 | .27 | .50 | .51 | .97 | 1.9 | .30 | .26 | .20 |
| 21 | .41 | .37 | .20 | .25 | .27 | .50 | .51 | 1.6 | 1.7 | .26 | .26 | .19 |
| 22 | .41 | .36 | .20 | .25 | .27 | .50 | .51 | 2.0 | 1.6 | .24 | .24 | .20 |
| 23 | .41 | .46 | .20 | .25 | .27 | .50 | .51 | 2.5 | 1.6 | .24 | .24 | .20 |
| 24 | .41 | .46 | .22 | .25 | .27 | .54 | .56 | 2.91 | 1.5 | .24 | .22 | .19 |
| 25 | .41 | .49 | .24 | .25 | .27 | .61 | .51 | 3.0 | 1.5 | .24 | .20 | .19 |
| 26 | .41 | .44 | .24 | .25 | .27 | .66 | .51 | 2.7 | 1.4 | .24 | .20 | .19 |
| 27 | .41 | .51 | .24 | .25 | .26 | .74 | .51 | 3.0 | 1.3 | .28 | .20 | .20 |
| 28 | .41 | .51 | .24 | .25 | .30 | .73 | .51 | 3.2 | 1.2 | .28 | .17 | .19 |
| 29 | .39 | .59 | .24 | .25 | --- | .70 | .56 | 3.6 | 1.2 | .28 | .17 | .19 |
| 30 | .37 | .57 | .24 | .25 | --- | .68 | .51 | 3.5 | 1.1 | .28 | .17 | .19 |
| 31 | .43 | | .24 | .25 | --- | .66 | --- | 4.6 | --- | .32 | .17 | --- |
| TOTAL | 12.83 | 12.77 | 9.62 | 7.83 | 7.98 | 14.57 | 16.19 | 65.27 | 67.9 | 13.85 | 7.27 | 5.56 |
| MEAN | .41 | .43 | .31 | .25 | .28 | .47 | .54 | 1.46 | 2.26 | .45 | .23 | .19 |
| MAX | .46 | .59 | .49 | .28 | .30 | .74 | .66 | 4.6 | 4.3 | .97 | .35 | .22 |
| MIN | .37 | .32 | .20 | .24 | .26 | .32 | .46 | .49 | 1.1 | .24 | .17 | .14 |
| AC-FT | 25 | 25 | 19 | 16 | 16 | 29 | 32 | 90 | 135 | 27 | 14 | 11 |

WTR YR 1978 TOTAL 227.64 MEAN .61 MAX 4.6 MIN .14 AC-FT 440

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UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - UTAH DISTRICT 08/13/91

STATION NUMBER 09324200 CTWD C AB STRAIGHT CANYON NR ORANGEVILLE, UT STREAM SOURCE AGENCY USGS
LATITUDE 391826 LONGITUDE 1111102 DRAINAGE AREA 21.90 DATUM STATE 49 COUNTY 015

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1978 TO SEPTEMBER 1979
MEAN VALUES

| DAY | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .22 | .32 | .42 | .26 | .26 | .40 | .71 | 1.0 | 6.2 | 1.5 | .66 | .39 |
| 2 | .22 | .97 | .40 | .26 | .27 | .45 | .64 | .94 | 5.9 | 1.4 | .65 | .38 |
| 3 | .24 | .41 | .39 | .26 | .29 | .42 | .61 | .90 | 3.7 | 1.5 | .63 | .37 |
| 4 | .24 | .37 | .39 | .25 | .28 | .45 | .69 | .92 | 3.7 | 1.4 | .61 | .38 |
| 5 | .24 | .37 | .39 | .25 | .27 | .49 | .77 | .92 | 3.7 | 1.4 | .60 | .34 |
| 6 | .26 | .35 | .38 | .25 | .28 | .56 | .81 | .92 | 3.8 | 1.4 | .58 | .33 |
| 7 | .28 | .35 | .38 | .25 | .29 | .97 | .84 | .92 | 3.9 | 1.4 | .57 | .31 |
| 8 | .28 | .37 | .38 | .25 | .32 | .66 | .89 | .92 | 4.0 | 1.3 | .56 | .34 |
| 9 | .28 | .37 | .37 | .25 | .30 | .49 | .86 | .92 | 3.9 | 1.3 | .55 | .37 |
| 10 | .28 | .37 | .36 | .25 | .30 | .47 | .81 | .87 | 3.6 | 1.2 | .51 | .40 |
| 11 | .28 | .38 | .35 | .25 | .32 | .56 | .83 | .90 | 3.5 | 1.1 | .51 | .32 |
| 12 | .28 | .39 | .34 | .25 | .32 | .62 | .81 | .87 | 3.4 | 1.1 | .55 | .30 |
| 13 | .28 | .39 | .33 | .25 | .34 | .55 | .84 | .84 | 3.4 | 1.1 | .69 | .32 |
| 14 | .28 | .39 | .32 | .25 | .33 | .65 | .87 | .90 | 3.3 | 1.0 | .70 | .32 |
| 15 | .30 | .39 | .31 | .25 | .35 | .60 | .95 | .90 | 3.2 | .99 | .68 | .35 |
| 16 | .30 | .38 | .30 | .25 | .35 | .60 | 1.1 | .90 | 3.2 | .95 | .70 | .36 |
| 17 | .30 | .38 | .30 | .25 | .37 | .59 | 1.2 | 1.1 | 3.1 | 1.0 | .90 | .33 |
| 18 | .30 | .39 | .29 | .25 | .32 | .56 | 1.1 | 1.4 | 3.1 | 1.1 | .75 | .32 |
| 19 | .28 | .37 | .29 | .25 | .35 | .56 | .98 | 2.2 | 3.1 | .94 | .79 | .32 |
| 20 | .28 | .42 | .29 | .25 | .36 | .59 | .91 | 3.1 | 2.9 | .95 | .74 | .37 |
| 21 | .30 | .42 | .29 | .25 | .37 | .58 | .93 | 3.7 | 2.6 | .95 | .65 | .34 |
| 22 | .28 | .42 | .28 | .24 | .37 | .62 | .93 | 4.6 | 2.5 | 1.0 | .57 | .37 |
| 23 | .28 | .42 | .29 | .26 | .34 | .58 | .92 | 5.1 | 2.3 | .94 | .50 | .37 |
| 24 | .28 | .42 | .28 | .27 | .38 | .56 | .93 | 5.2 | 2.0 | .87 | .46 | .35 |
| 25 | .28 | .44 | .27 | .28 | .38 | .68 | .84 | 5.2 | 1.8 | .83 | .47 | .37 |
| 26 | .28 | .44 | .27 | .28 | .41 | .67 | .85 | 5.0 | 1.9 | .81 | .47 | .35 |
| 27 | .30 | .44 | .26 | .28 | .44 | .66 | .85 | 4.8 | 1.7 | .76 | .47 | .35 |
| 28 | .30 | .44 | .26 | .26 | .41 | .72 | .92 | 4.8 | 1.7 | .73 | .45 | .35 |
| 29 | .30 | .44 | .26 | .27 | --- | .71 | .94 | 4.7 | 1.5 | .71 | .40 | .35 |
| 30 | .28 | .45 | .26 | .26 | --- | .70 | .90 | 4.6 | 1.45 | .69 | .40 | .35 |
| 31 | .30 | --- | .26 | .25 | --- | .69 | --- | 4.4 | --- | .68 | .40 | --- |
| TOTAL | 8.60 | 12.46 | 9.93 | 7.94 | 9.37 | 18.91 | 26.23 | 76.46 | 90.1 | 32.97 | 18.13 | 10.49 |
| MEAN | .28 | .42 | .32 | .26 | .33 | .60 | .87 | 2.40 | 3.00 | 1.06 | .58 | .35 |
| MAX | .30 | .97 | .42 | .28 | .44 | .97 | 1.2 | 5.2 | 6.2 | 1.5 | .90 | .40 |
| MIN | .22 | .32 | .24 | .24 | .26 | .40 | .61 | .84 | 1.5 | .68 | .40 | .32 |
| AC-FT | 17 | 25 | 20 | 16 | 19 | 37 | 52 | 148 | 179 | 65 | 36 | 21 |

CAL YR 1978 TOTAL 217.41 MEAN .60 MAX 6.6 MIN .14 AC-FT 431
WTR YR 1979 TOTAL 319.26 MEAN .87 MAX 6.2 MIN .22 AC-FT 633

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1999

# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 10/01/1977 | 0.37 |
| 10/06/1977 | 0.41 |
| 10/11/1977 | 0.44 |
| 10/16/1977 | 0.41 |
| 10/21/1977 | 0.41 |
| 10/26/1977 | 0.41 |
| 11/01/1977 | 0.41 |
| 11/06/1977 | 0.44 |
| 11/11/1977 | 0.46 |
| 11/16/1977 | 0.41 |
| 11/21/1977 | 0.37 |
| 11/26/1977 | 0.44 |
| 12/01/1977 | 0.44 |
| 12/06/1977 | 0.41 |
| 12/11/1977 | 0.30 |
| 12/16/1977 | 0.35 |
| 12/21/1977 | 0.20 |
| 12/26/1977 | 0.24 |
| 01/01/1978 | 0.24 |
| 01/06/1978 | 0.26 |
| 01/11/1978 | 0.25 |
| 01/16/1978 | 0.25 |
| 01/21/1978 | 0.25 |
| 01/26/1978 | 0.25 |
| 02/01/1978 | 0.26 |
| 02/06/1978 | 0.30 |
| 02/11/1978 | 0.30 |
| 02/16/1978 | 0.28 |
| 02/21/1978 | 0.27 |
| 02/26/1978 | 0.27 |
| 03/01/1978 | 0.32 |
| 03/06/1978 | 0.34 |
| 03/11/1978 | 0.40 |
| 03/16/1978 | 0.41 |
| 03/21/1978 | 0.50 |
| 03/26/1978 | 0.66 |
| 04/01/1978 | 0.64 |
| 04/06/1978 | 0.59 |
| 04/11/1978 | 0.54 |
| 04/16/1978 | 0.49 |
| 04/21/1978 | 0.51 |
| 04/26/1978 | 0.51 |
| 05/01/1978 | 0.64 |
| 05/06/1978 | 0.56 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 05/11/1978 | 0.51 |
| 05/16/1978 | 0.49 |
| 05/21/1978 | 1.60 |
| 05/26/1978 | 2.70 |
| 06/01/1978 | 4.30 |
| 06/06/1978 | 2.80 |
| 06/11/1978 | 2.70 |
| 06/16/1978 | 2.10 |
| 06/21/1978 | 1.70 |
| 06/26/1978 | 1.40 |
| 07/01/1978 | 0.97 |
| 07/06/1978 | 0.70 |
| 07/11/1978 | 0.49 |
| 07/16/1978 | 0.37 |
| 07/21/1978 | 0.26 |
| 07/26/1978 | 0.24 |
| 08/01/1978 | 0.28 |
| 08/06/1978 | 0.24 |
| 08/11/1978 | 0.24 |
| 08/16/1978 | 0.24 |
| 08/21/1978 | 0.26 |
| 08/26/1978 | 0.20 |
| 09/01/1978 | 0.17 |
| 09/06/1978 | 0.14 |
| 09/11/1978 | 0.19 |
| 09/16/1978 | 0.20 |
| 09/21/1978 | 0.19 |
| 09/26/1978 | 0.19 |
| 10/01/1978 | 0.22 |
| 10/06/1978 | 0.26 |
| 10/11/1978 | 0.28 |
| 10/16/1978 | 0.30 |
| 10/21/1978 | 0.30 |
| 10/26/1978 | 0.28 |
| 11/01/1978 | 0.32 |
| 11/06/1978 | 0.35 |
| 11/11/1978 | 0.38 |
| 11/16/1978 | 0.38 |
| 11/21/1978 | 0.42 |
| 11/26/1978 | 0.44 |
| 12/01/1978 | 0.42 |
| 12/06/1978 | 0.38 |
| 12/11/1978 | 0.35 |
| 12/16/1978 | 0.30 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 12/21/1978 | 0.28 |
| 12/26/1978 | 0.27 |
| 01/01/1979 | 0.26 |
| 01/06/1979 | 0.25 |
| 01/11/1979 | 0.25 |
| 01/16/1979 | 0.25 |
| 01/21/1979 | 0.25 |
| 01/26/1979 | 0.28 |
| 02/01/1979 | 0.26 |
| 02/06/1979 | 0.28 |
| 02/11/1979 | 0.32 |
| 02/16/1979 | 0.35 |
| 02/21/1979 | 0.37 |
| 02/26/1979 | 0.41 |
| 03/01/1979 | 0.40 |
| 03/06/1979 | 0.56 |
| 03/11/1979 | 0.56 |
| 03/16/1979 | 0.60 |
| 03/21/1979 | 0.58 |
| 03/26/1979 | 0.67 |
| 04/01/1979 | 0.71 |
| 04/06/1979 | 0.81 |
| 04/11/1979 | 0.83 |
| 04/16/1979 | 1.10 |
| 04/21/1979 | 0.93 |
| 04/26/1979 | 0.85 |
| 05/01/1979 | 1.00 |
| 05/06/1979 | 0.92 |
| 05/11/1979 | 0.90 |
| 05/16/1979 | 0.90 |
| 05/21/1979 | 3.70 |
| 05/26/1979 | 5.00 |
| 06/01/1979 | 4.20 |
| 06/06/1979 | 3.80 |
| 06/11/1979 | 3.50 |
| 06/16/1979 | 3.20 |
| 06/21/1979 | 2.60 |
| 06/26/1979 | 1.90 |
| 07/01/1979 | 1.50 |
| 07/06/1979 | 1.30 |
| 07/11/1979 | 1.10 |
| 07/16/1979 | 0.98 |
| 07/21/1979 | 0.95 |
| 07/26/1979 | 0.81 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 08/01/1979 | 0.66 |
| 08/06/1979 | 0.58 |
| 08/11/1979 | 0.51 |
| 08/16/1979 | 0.70 |
| 08/21/1979 | 0.65 |
| 08/26/1979 | 0.47 |
| 09/01/1979 | 0.39 |
| 09/06/1979 | 0.33 |
| 09/11/1979 | 0.32 |
| 09/16/1979 | 0.35 |
| 09/21/1979 | 0.39 |
| 09/26/1979 | 0.35 |
| 10/01/1979 | 0.40 |
| 10/06/1979 | 0.42 |
| 10/11/1979 | 0.35 |
| 10/16/1979 | 0.49 |
| 10/21/1979 | 0.49 |
| 10/26/1979 | 0.45 |
| 11/01/1979 | 0.38 |
| 11/06/1979 | 0.33 |
| 11/11/1979 | 0.30 |
| 11/16/1979 | 0.28 |
| 11/21/1979 | 0.27 |
| 11/26/1979 | 0.27 |
| 12/01/1979 | |
| 12/06/1979 | |
| 12/11/1979 | |
| 12/16/1979 | |
| 12/21/1979 | |
| 12/26/1979 | |
| 01/01/1980 | |
| 01/06/1980 | |
| 01/11/1980 | |
| 01/16/1980 | |
| 01/21/1980 | |
| 01/26/1980 | |
| 02/01/1980 | |
| 02/06/1980 | |
| 02/11/1980 | |
| 02/16/1980 | |
| 02/21/1980 | |
| 02/26/1980 | |
| 03/01/1980 | |
| 03/06/1980 | |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 03/11/1980 | |
| 03/16/1980 | |
| 03/21/1980 | |
| 03/26/1980 | |
| 04/01/1980 | |
| 04/06/1980 | |
| 04/11/1980 | |
| 04/16/1980 | |
| 04/21/1980 | |
| 04/26/1980 | |
| 05/01/1980 | 1.30 |
| 05/06/1980 | 2.50 |
| 05/11/1980 | 2.10 |
| 05/16/1980 | 2.30 |
| 05/21/1980 | 3.10 |
| 05/26/1980 | 10.00 |
| 06/01/1980 | 13.00 |
| 06/06/1980 | 16.00 |
| 06/11/1980 | 8.00 |
| 06/16/1980 | 9.70 |
| 06/21/1980 | 7.80 |
| 06/26/1980 | 6.40 |
| 07/01/1980 | 5.80 |
| 07/06/1980 | 4.80 |
| 07/11/1980 | 3.90 |
| 07/16/1980 | 3.30 |
| 07/21/1980 | 2.70 |
| 07/26/1980 | 2.40 |
| 08/01/1980 | 2.10 |
| 08/06/1980 | 1.80 |
| 08/11/1980 | 1.80 |
| 08/16/1980 | 2.00 |
| 08/21/1980 | 2.10 |
| 08/26/1980 | 2.00 |
| 09/01/1980 | 1.90 |
| 09/06/1980 | 1.60 |
| 09/11/1980 | 2.00 |
| 09/16/1980 | 1.60 |
| 09/21/1980 | 1.40 |
| 09/26/1980 | 1.40 |
| 10/01/1980 | 1.10 |
| 10/06/1980 | 1.30 |
| 10/11/1980 | 1.20 |
| 10/16/1980 | 1.40 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 10/21/1980 | 1.20 |
| 10/26/1980 | 1.20 |
| 11/01/1980 | 1.20 |
| 11/06/1980 | 1.20 |
| 11/11/1980 | 1.20 |
| 11/16/1980 | 0.73 |
| 11/21/1980 | 0.48 |
| 11/26/1980 | 0.54 |
| 12/01/1980 | |
| 12/06/1980 | |
| 12/11/1980 | |
| 12/16/1980 | |
| 12/21/1980 | |
| 12/26/1980 | |
| 01/01/1981 | |
| 01/06/1981 | |
| 01/11/1981 | |
| 01/16/1981 | |
| 01/21/1981 | |
| 01/26/1981 | |
| 02/01/1981 | |
| 02/06/1981 | |
| 02/11/1981 | |
| 02/16/1981 | |
| 02/21/1981 | |
| 02/26/1981 | |
| 03/01/1981 | |
| 03/06/1981 | |
| 03/11/1981 | |
| 03/16/1981 | |
| 03/21/1981 | |
| 03/26/1981 | |
| 04/01/1981 | |
| 04/06/1981 | |
| 04/11/1981 | |
| 04/16/1981 | |
| 04/21/1981 | |
| 04/26/1981 | |
| 05/01/1981 | 0.90 |
| 05/06/1981 | 0.95 |
| 05/11/1981 | 0.96 |
| 05/16/1981 | 1.00 |
| 05/21/1981 | 1.00 |
| 05/26/1981 | 0.99 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 06/01/1981 | 0.85 |
| 06/06/1981 | 0.90 |
| 06/11/1981 | 0.68 |
| 06/16/1981 | 0.65 |
| 06/21/1981 | 0.66 |
| 06/26/1981 | 0.48 |
| 07/01/1981 | 0.56 |
| 07/06/1981 | 0.49 |
| 07/11/1981 | 0.63 |
| 07/16/1981 | 0.40 |
| 07/21/1981 | 0.35 |
| 07/26/1981 | 0.46 |
| 08/01/1981 | 0.40 |
| 08/06/1981 | 0.14 |
| 08/11/1981 | 0.31 |
| 08/16/1981 | 0.35 |
| 08/21/1981 | 0.24 |
| 08/26/1981 | 0.28 |
| 09/01/1981 | 0.31 |
| 09/06/1981 | 0.65 |
| 09/11/1981 | 0.76 |
| 09/16/1981 | 0.48 |
| 09/21/1981 | 0.39 |
| 09/26/1981 | 0.50 |
| 10/29/1981 | 0.67 |
| 12/01/1981 | 1.70 |
| 12/31/1981 | 0.00 |
| 01/18/1982 | 0.00 |
| 02/05/1982 | 0.00 |
| 03/18/1982 | 0.81 |
| 04/22/1982 | 0.87 |
| 05/28/1982 | 4.87 |
| 06/01/1982 | 4.60 |
| 07/01/1982 | 2.27 |
| 08/12/1982 | 1.06 |
| 08/13/1982 | 1.78 |
| 09/02/1982 | 0.00 |
| 09/30/1982 | 2.18 |
| 10/11/1982 | 0.83 |
| 11/23/1982 | 0.00 |
| 12/13/1982 | 1.59 |
| 01/04/1983 | 1.06 |
| 02/22/1983 | 1.40 |
| 03/15/1983 | 1.40 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 05/20/1983 | 3.32 |
| 05/27/1983 | 6.25 |
| 06/08/1983 | 6.25 |
| 06/27/1983 | 6.25 |
| 07/15/1983 | 6.25 |
| 08/19/1983 | 3.81 |
| 10/10/1983 | 2.18 |
| 10/31/1983 | 2.10 |
| 11/15/1983 | 1.94 |
| 12/12/1983 | 1.86 |
| 01/09/1984 | 1.98 |
| 02/07/1984 | 1.78 |
| 03/06/1984 | 1.74 |
| 04/05/1984 | 1.94 |
| 05/01/1984 | 4.07 |
| 06/01/1984 | 13.39 |
| 07/01/1984 | 6.47 |
| 08/01/1984 | 4.07 |
| 09/01/1984 | 2.85 |
| 10/01/1984 | 2.61 |
| 11/01/1984 | 3.02 |
| 12/01/1984 | 3.13 |
| 01/01/1985 | 2.62 |
| 02/01/1985 | 2.75 |
| 03/01/1985 | 2.75 |
| 04/01/1985 | 3.03 |
| 05/01/1985 | 14.51 |
| 06/01/1985 | 12.02 |
| 07/01/1985 | 4.49 |
| 08/01/1985 | 3.18 |
| 09/01/1985 | 2.62 |
| 10/01/1985 | 2.85 |
| 11/01/1985 | 3.56 |
| 12/01/1985 | 3.56 |
| 01/24/1986 | 3.56 |
| 02/11/1986 | 2.79 |
| 03/12/1986 | 2.61 |
| 04/07/1986 | 2.79 |
| 05/13/1986 | 4.07 |
| 06/10/1986 | 5.72 |
| 07/24/1986 | 2.67 |
| 08/13/1986 | 2.31 |
| 09/08/1986 | 2.31 |
| 10/14/1986 | 2.14 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 11/14/1986 | 2.10 |
| 12/09/1986 | 2.18 |
| 01/13/1987 | 2.14 |
| 02/24/1987 | 2.18 |
| 03/17/1987 | 2.06 |
| 04/08/1987 | 1.98 |
| 05/21/1987 | 2.40 |
| 06/16/1987 | 2.40 |
| 07/15/1987 | 1.98 |
| 08/11/1987 | 1.63 |
| 09/17/1987 | 1.52 |
| 10/21/1987 | 1.37 |
| 11/17/1987 | 1.41 |
| 12/15/1987 | 1.13 |
| 02/12/1988 | 1.82 |
| 03/23/1988 | 1.41 |
| 04/18/1988 | 1.59 |
| 05/16/1988 | 2.71 |
| 06/07/1988 | 1.63 |
| 07/14/1988 | 1.34 |
| 08/15/1988 | 1.22 |
| 09/13/1988 | 1.41 |
| 10/12/1988 | 1.37 |
| 11/14/1988 | 1.44 |
| 12/15/1988 | 1.23 |
| 01/31/1989 | 1.23 |
| 02/27/1989 | 1.22 |
| 03/30/1989 | 1.34 |
| 04/17/1989 | 1.41 |
| 05/11/1989 | 1.23 |
| 06/19/1989 | 1.23 |
| 07/19/1989 | 1.13 |
| 08/15/1989 | 1.34 |
| 09/12/1989 | 1.22 |
| 10/10/1989 | 1.30 |
| 11/14/1989 | 1.10 |
| 12/05/1989 | 1.06 |
| 01/09/1990 | 0.76 |
| 02/19/1990 | 0.76 |
| 03/05/1990 | 0.91 |
| 04/16/1990 | 0.62 |
| 05/10/1990 | 0.76 |
| 06/06/1990 | 0.49 |
| 07/11/1990 | 0.49 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 08/13/1990 | 0.26 |
| 09/07/1990 | 0.18 |
| 10/08/1990 | 0.09 |
| 11/12/1990 | 0.09 |
| 12/17/1990 | 0.04 |
| 04/09/1991 | 0.11 |
| 06/06/1991 | 0.89 |
| 07/16/1991 | 0.24 |
| 08/20/1991 | 0.24 |
| 09/12/1991 | 0.03 |
| 11/04/1991 | 0.44 |
| 12/13/1991 | 0.24 |
| 02/04/1992 | 0.17 |
| 03/19/1992 | 0.28 |
| 04/10/1992 | 0.06 |
| 05/21/1992 | 0.46 |
| 06/03/1992 | 0.09 |
| 07/22/1992 | 0.01 |
| 08/11/1992 | 0.01 |
| 10/22/1992 | 0.01 |
| 11/25/1992 | 0.00 |
| 12/01/1992 | 0.00 |
| 03/23/1993 | 0.44 |
| 04/30/1993 | 0.30 |
| 05/19/1993 | 2.98 |
| 06/10/1993 | 3.08 |
| 07/23/1993 | 0.09 |
| 08/06/1993 | 0.00 |
| 09/10/1993 | 0.00 |
| 10/30/1993 | 0.04 |
| 11/19/1993 | 0.00 |
| 12/13/1993 | 0.00 |
| 01/04/1994 | 0.00 |
| 02/07/1994 | 0.00 |
| 03/24/1994 | 0.00 |
| 04/28/1994 | 0.00 |
| 05/17/1994 | 0.00 |
| 06/22/1994 | 0.00 |
| 07/21/1994 | 0.00 |
| 08/23/1994 | 0.00 |
| 09/12/1994 | 0.00 |
| 10/31/1994 | 0.00 |
| 11/17/1994 | 0.00 |
| 12/19/1994 | 0.00 |

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# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 01/31/1995 | 0.00 |
| 02/06/1995 | 0.00 |
| 03/29/1995 | 0.00 |
| 04/21/1995 | 0.00 |
| 05/08/1995 | 0.00 |
| 06/29/1995 | 5.58 |
| 07/17/1995 | 0.49 |
| 08/30/1995 | 0.06 |
| 09/28/1995 | 0.17 |
| 11/30/1995 | 0.04 |
| 12/18/1995 | 0.03 |
| 01/31/1996 | 0.00 |
| 02/26/1996 | 0.00 |
| 03/26/1996 | 0.00 |
| 04/30/1996 | 0.02 |
| 05/23/1996 | 1.76 |
| 06/10/1996 | 1.90 |
| 07/19/1996 | 0.02 |
| 08/20/1996 | 0.00 |
| 09/04/1996 | 0.00 |
| 10/22/1996 | 0.00 |
| 11/21/1996 | 0.00 |
| 12/26/1996 | 0.00 |
| 01/31/1997 | 0.00 |
| 2-31-97 | 0.00 |
| 03/11/1997 | 0.00 |
| 04/07/1997 | 0.07 |
| 05/27/1997 | 2.23 |
| 06/23/1997 | 0.62 |
| 07/23/1997 | 0.91 |
| 08/25/1997 | 1.06 |
| 09/08/1997 | 0.63 |
| 10/14/1997 | 0.20 |
| 11/21/1997 | 0.45 |
| 12/05/1997 | 0.33 |
| 01/27/1998 | 0.26 |
| 02/16/1998 | 0.18 |
| 03/20/1998 | 0.49 |
| 04/13/1998 | 0.22 |
| 05/28/1998 | 5.58 |
| 06/11/1998 | 5.58 |
| 07/08/1998 | 2.23 |
| 08/19/1998 | 0.45 |
| 09/03/1998 | 0.73 |

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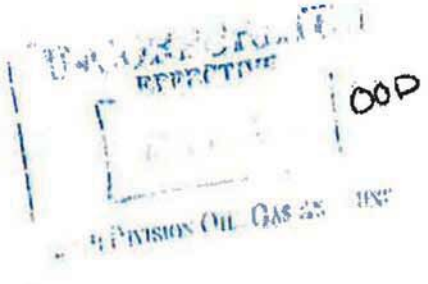
# Cottonwood Canyon Creek Flow @ USGS Flume

| Date | Discharge (cfs) |
|---|---|
| 10/02/1998 | 1.06 |
| 11/03/1998 | 1.34 |
| 12/10/1998 | 0.81 |
| 01/05/1999 | 0.89 |
| 02/01/1999 | 0.76 |
| 03/01/1999 | 1.86 |
| 04/07/1999 | 1.00 |
| 05/05/1999 | 1.16 |
| 06/08/1999 | 2.79 |
| 07/16/1999 | 1.78 |
| 08/03/1999 | 0.76 |
| 09/02/1999 | 1.40 |
| 10/04/1999 | 0.53 |
| 11/01/1999 | 0.53 |
| 12/06/1999 | 0.46 |
| 01/11/2000 | 0.73 |
| 02/02/2000 | 0.49 |
| 03/06/2000 | 0.44 |
| 04/05/2000 | 1.86 |
| 05/03/2000 | 1.26 |
| 06/02/2000 | 0.26 |

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# *VOLUME 9*
# *HYDROLOGIC SECTION*

## *Appendix C*

## Cottonwood Canyon Creek
## Hydrogeologic Investigation

## Attachment 3
## TM-23
## Field Data Sheets
## Historical Flow Data

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E.I.S. Hyrology
Field Measurements Form

Station #

Date 6/30/84
Company Baird Geol
Flow/Depth D.
pH
Sp. Cond.
W. Temp.
Air Temp. 81
Diss. O
Time 16:10
Type: Spring ✓ Stream___ Well___ Discharge___ NPDES___
Collection POint:
Appearance of Water: Clear___ Milky___ Cloudy___ Opaque___
Weather: Clear___ Part. Cloudy ✓ Overcast___ Rain___ Snow___
Quality Sample Taken: Yes___ No ✓
Comments
Field Monitor
Pump Reading

When Sample or Measurements Not Taken:
Reason: D

D = Dry F = Frozen N/A = Not Accessable N/R = Not Required

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E.I.S. Hyrology

Field Measurements Form

TM-25
Station #

Date 7/19/99

Company Brown Cuch

Flow/Depth app 2gpm *

pH 7.8

Sp. Cond. 240

W. Temp. 40

Air Temp. 91

Diss. O N/A

Time 11:11

Type: Spring ✓ Stream ___ Well ___ Discharge ___ NPDES ___

Collection POint: Spring

Appearance of Water: Clear ✓ Milky ___ Cloudy ___ Opaque ___

Weather: Clear ✓ Part. Cloudy ___ Overcast ___ Rain ___ Snow ___

Quality Sample Taken: Yes ✓ No ___

Comments * Pip all But dry app 2gpm seeping up at Base of Channel

Field Monitor M. L. Connor

Pump Reading ___

When Sample or Measurements Not Taken:

Reason: ___

D = Dry F = Frozen N/A = Not Accessable N/R = Not Required

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E.I.S. Hyrology

Field Measurements Form

TTL-8

Station #

Date 8/89

Company Travis Peak

Flow/Depth 4 gpm

pH 7.2

Sp. Cond. 750

W. Temp. 8°

Air Temp. 84

Diss. O NA

Time 12:20

Type: Spring ✓ Stream ___ Well ___ Discharge ___ NPDES ___

Collection POint: Below Pipe

Appearance of Water: Clear ✓ Milky ___ Cloudy ___ Opaque ___

Weather: Clear ✓ Part. Cloudy ___ Overcast ___ Rain ___ Snow ___

Quality Sample Taken: Yes ✓ No ___

Comments (Pipe not flowing)

Field Monitor J. M. Thomas

Pump Reading ___

When Sample or Measurements Not Taken:

Reason: ___

D = Dry F = Frozen N/A = Not Accessable N/R = Not Required

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# Cottnwood Spring Flow Data

| Date | Flow (GPM) | Source | Flow (GPM) | Source | Flow (GPM) | Source | Flow (GPM) | Source | Flow (GPM) | Source |
|---|---|---|---|---|---|---|---|---|---|---|
| 06/08/1978 | 43.0 | USGS | | | | | | | | |
| 06/28/1978 | 41.0 | USGS | | | | | | | | |
| 07/10/1978 | 35.0 | USGS | | | | | | | | |
| 07/27/1978 | 33.0 | USGS | | | | | | | | |
| 08/09/1978 | 33.0 | USGS | | | | | | | | |
| 09/08/1978 | 38.0 | USGS | | | | | | | | |
| 10/09/1978 | 37.0 | USGS | | | | | | | | |
| 10/13/1978 | 38.0 | USGS | | | | | | | | |
| 10/22/1978 | 41.0 | USGS | | | | | | | | |
| 12/22/1978 | 47.0 | USGS | | | | | | | | |
| 03/08/1979 | 44.0 | USGS | | | | | | | | |
| 05/31/1979 | 72.0 | USGS | | | | | | | | |
| 06/12/1979 | 83.0 | USGS | | | | | | | | |
| 07/06/1979 | 67.0 | USGS | | | | | | | | |
| 07/19/1979 | 64.0 | USGS | | | | | | | | |
| 08/28/1979 | 55.0 | USGS | | | | | | | | |
| 07/14/1981 | 80.0 | USGS | | | | | | | | |
| 07/30/1981 | 78.0 | USGS | | | | | | | | |
| 08/20/1981 | 73.0 | USGS | | | | | | | | |
| 09/24/1981 | 78.0 | USGS | | | | | | | | |
| 05/20/1982 | 80.0 | USGS | | | | | | | | |
| 06/23/1982 | 76.0 | USGS | | | | | | | | |
| 07/17/1982 | 96.0 | USGS | | | | | | | | |
| 08/10/1982 | 98.0 | USGS | | | | | | | | |
| 09/08/1982 | 110.0 | USGS | | | | | | | | |
| 10/28/1985 | | | 4.0 | JBR | | | | | | |
| 09/30/1986 | | | | | 22.5 | TMCC | | | | |
| 10/20/1986 | | | | | 20.0 | TMCC | | | | |
| 11/11/1986 | | | | | 20.8 | TMCC | | | | |
| 06/30/1987 | | | | | 12.6 | TMCC | | | | |
| 07/15/1987 | | | | | 12.0 | TMCC | | | | |
| 08/31/1987 | | | | | | | 12.0 | BCCC | | |
| 09/25/1987 | | | | | | | 12.0 | BCCC | | |
| 06/30/1988 | | | | | | | 0.0 | BCCC | | |
| 09/20/1988 | | | | | | | 22.0 | BCCC | | |
| 10/31/1988 | | | | | | | 21.0 | BCCC | | |
| 11/29/1988 | | | | | | | 19.0 | BCCC | | |
| 12/07/1988 | | | | | | | 19.2 | BCCC | | |
| 03/13/1989 | | | | | | | 21.5 | BCCC | | |
| 05/25/1989 | | | | | | | 18.5 | BCCC | | |
| 07/19/1989 | | | | | | | 12.0 | BCCC | | |
| 08/25/1989 | | | | | | | 4.0 | BCCC | | |
| 09/17/1989 | | | | | | | 0.0 | BCCC | | |
| 03/01/1990 | | | | | | | 0.0 | BCCC | | |
| 05/28/1990 | | | | | | | 0.0 | BCCC | | |
| 07/24/1990 | | | | | | | 0.0 | BCCC | | |
| 08/23/1990 | | | | | | | 0.0 | BCCC | | |
| 09/28/1990 | | | | | | | 0.0 | BCCC | | |
| 10/26/1990 | | | | | | | 0.0 | BCCC | | |
| 02/28/1991 | | | | | | | 0.0 | BCCC | | |
| 06/17/1991 | | | | | | | 0.0 | BCCC | | |
| 08/23/1991 | | | | | | | 0.0 | BCCC | | |

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## Cottnwood Spring Flow Data

| Date | Flow (GPM) | Source | Flow (GPM) | Source | Flow (GPM) | Source | Flow (GPM) | Source | Flow (GPM) | Source | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/25/1991 | | | | | | | 0.0 | BCCC | | | |
| 02/25/1992 | | | | | | | 0.0 | BCCC | | | |
| 05/13/1992 | | | | | | | 0.0 | BCCC | | | |
| 12/15/1992 | | | | | | | | | 0.0 | EW | |
| 05/19/1993 | | | | | | | | | 0.0 | EW | |
| 07/21/1993 | | | | | | | | | 0.0 | EW | |
| 07/01/1994 | | | | | | | | | 0.0 | EW | |
| 07/01/1995 | | | | | | | | | 0.0 | EW | |
| 07/01/1996 | | | | | | | | | 0.0 | EW | |
| 07/01/1997 | | | | | | | | | 0.0 | EW | |
| 11/02/1998 | | | | | | | | | 57.8 | EW | |
| 03/29/1999 | | | | | | | | | 96.7 | EW | |
| 07/13/1999 | | | | | | | | | 84.4 | EW | |
| 08/30/1999 | | | | | | | | | 49.2 | EW * | * Difficulty Sealing Weir @ Below Roans Site, measuerd @ 49.2 GPM |
| 10/06/1999 | | | | | | | | | 85.5 | EW | |
| 11/10/1999 | | | | | | | | | 96.9 | EW | |
| 08/05/2000 | | | | | | | | | 39.7 | EW | |

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# *VOLUME 9*
# *HYDROLOGIC SECTION*

## *Appendix C*

## Cottonwood Canyon Creek Hydrogeologic Investigation

## Attachment 4
## Cottonwood Canyon Creek Gain\Loss Data

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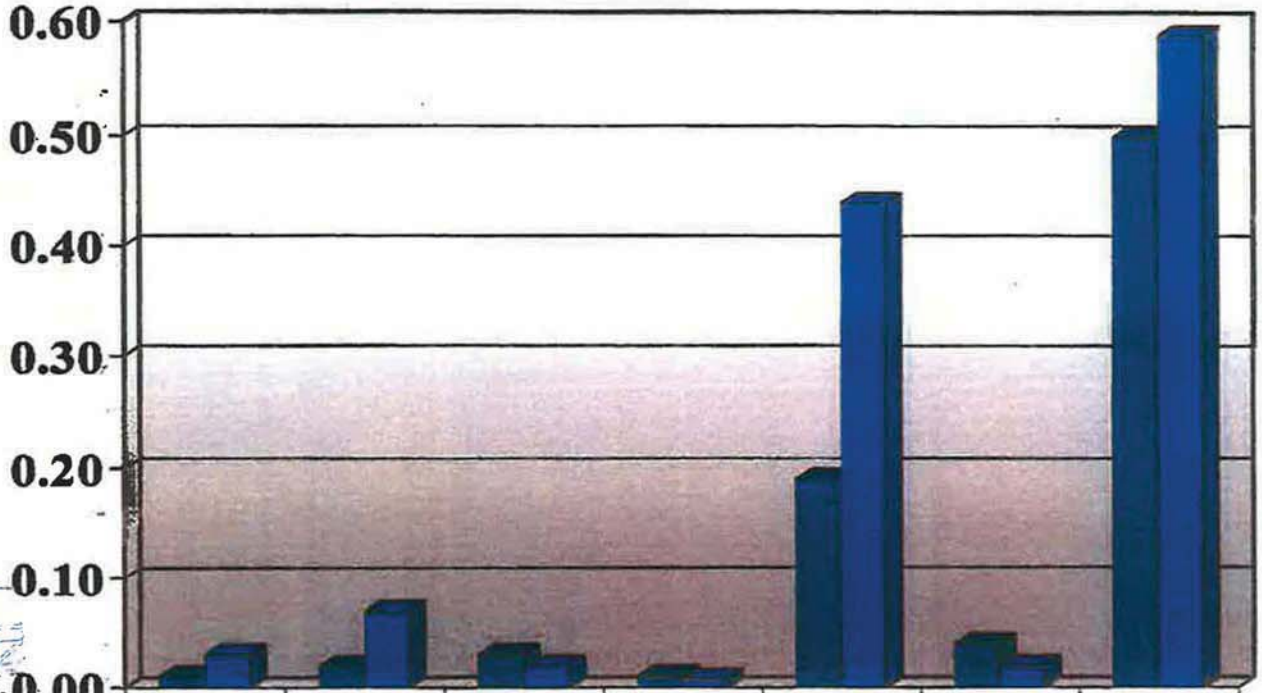
# Cottonwood Canyon Creek

## Flow Data Comparison

## USGS August 1979* Energy West November 1998




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM-23 | Roans Canyon | Cottonwood Creek - Below Roans |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | 0.04 | 0.50 |
| EW-11/1998 | 0.03 | 0.07 | 0.02 | 0.007 | 0.44 | 0.02 | 0.59 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 57.8 GPM/0.13 CFS

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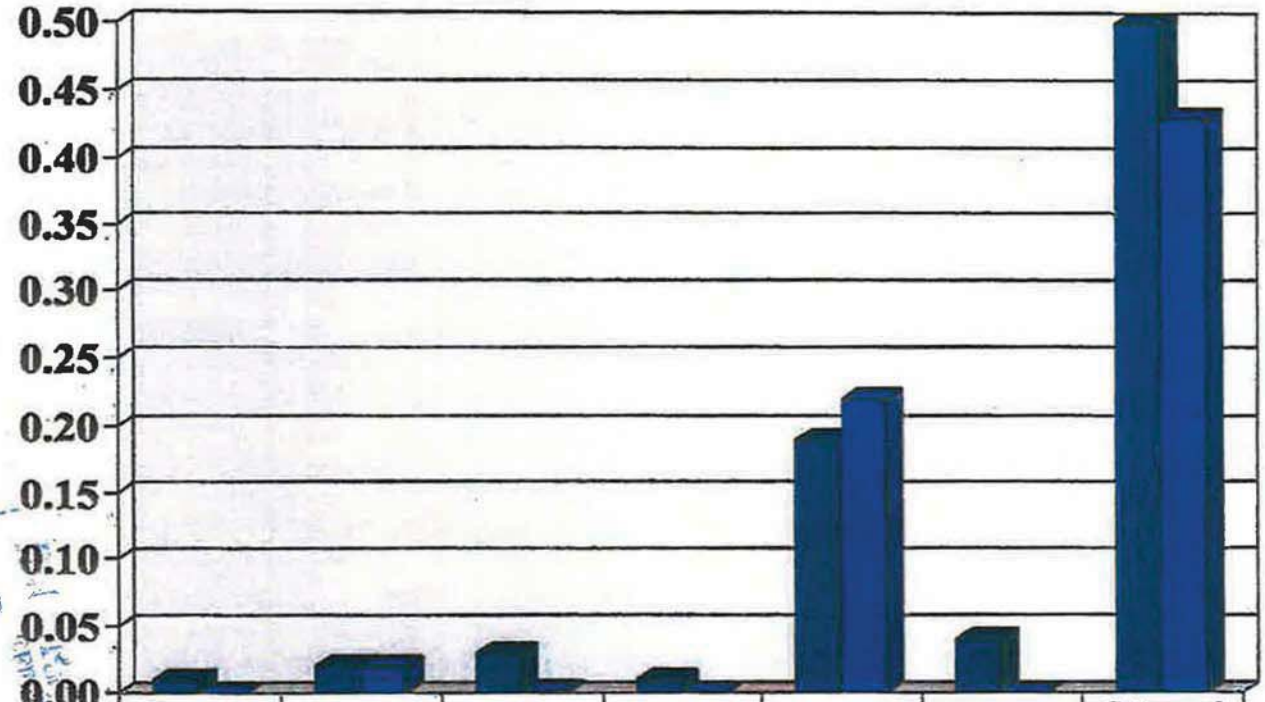
# Cottonwood Canyon Creek

## Flow Data Comparison

## USGS August 1979* Energy West March 1999




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM-23 | Roans Canyon | Cottonwood Creek - Below Roans |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | 0.04 | 0.50 |
| EW-03/1999 | 0 | 0.02 | 0.0015 | 0 | 0.22 | 0 | 0.43 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow =96.7 GPM/0.22 CFS

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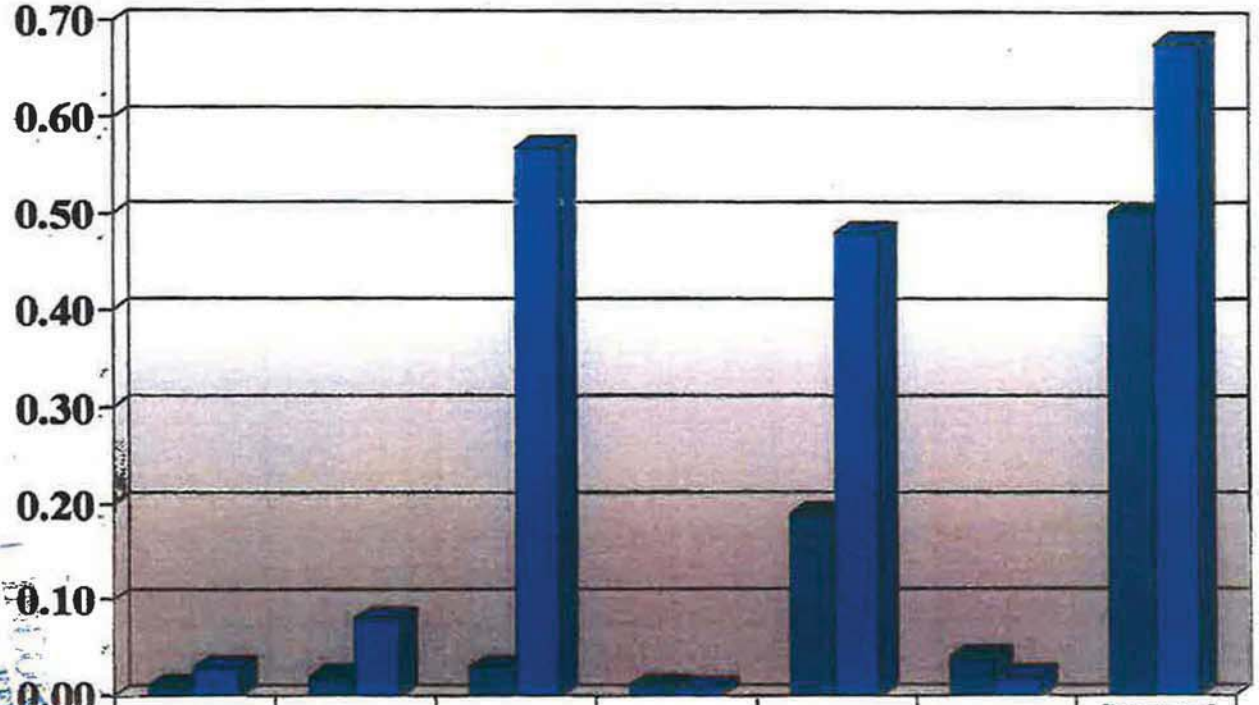
# Cottonwood Canyon Creek

## Flow Data Comparison

## USGS August 1979* Energy West July 1999




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM-23 | Roans Canyon | Cottonwood Creek - Below Roans |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | 0.04 | 0.50 |
| EW-07/1999 | 0.03 | 0.08 | 0.57 | 0.008 | 0.48 | 0.02 | 0.68 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 84.4 GPM/0.19 CFS

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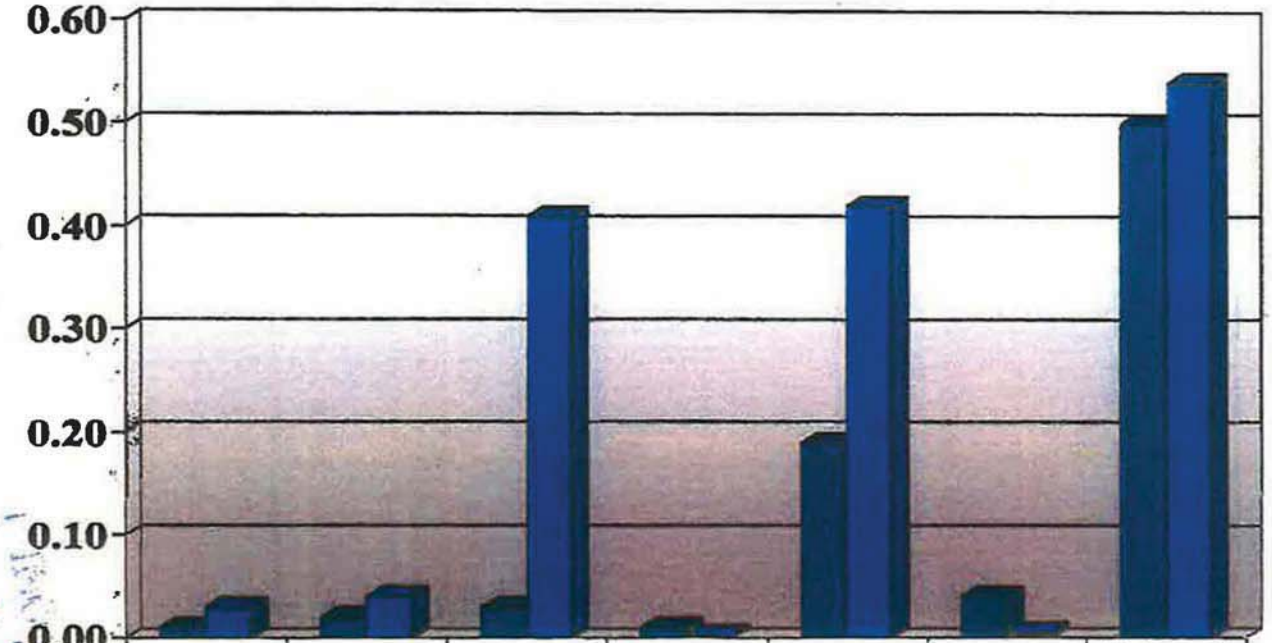
# Cottonwood Canyon Creek

## Flow Data Comparison

## USGS August 1979* Energy West August 1999




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM-23 | Roans Canyon | Cottonwood Creek - Below Roans * |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | 0.04 | 0.50 |
| EW-08/1999 | 0.03 | 0.04 | 0.41 | 0.002 | 0.42 | 0.005 | 0.54 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 49.6 GPM/0.11 CFS

* Difficulty Sealing Weir @ Below Roans Site

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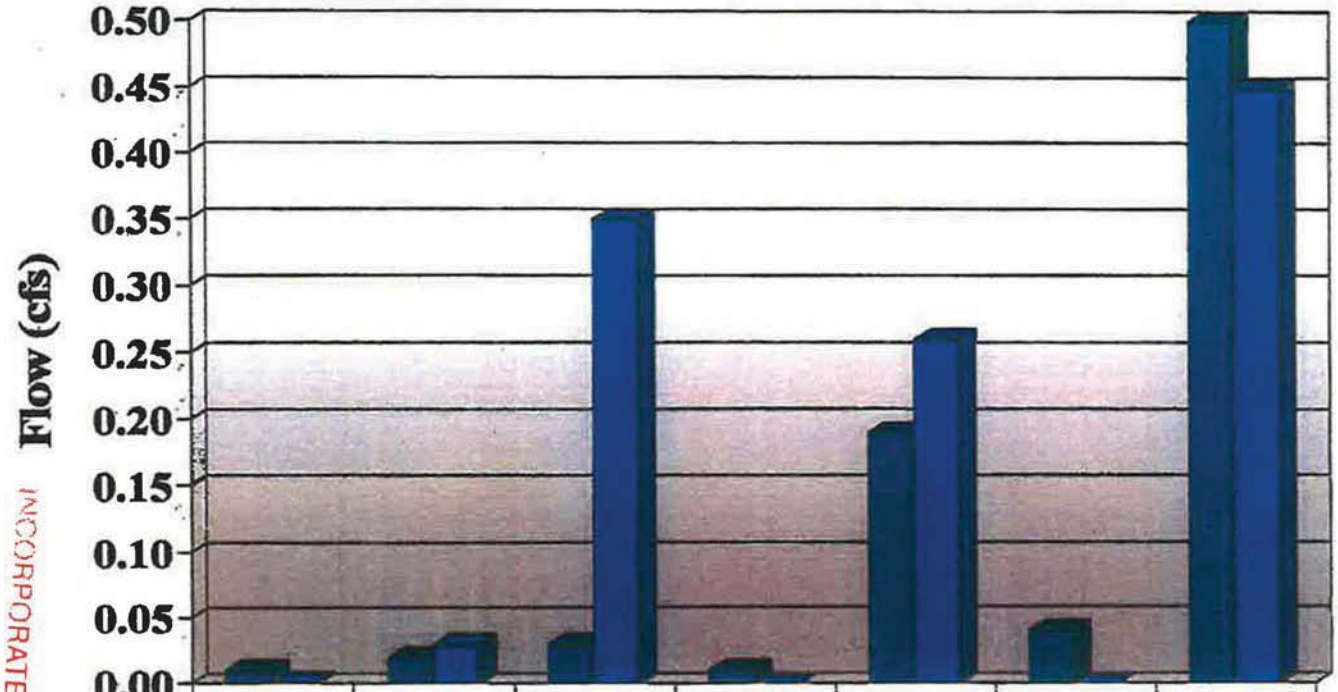
# Cottonwood Canyon Creek

## Flow Data Comparison

## USGS August 1979* Energy West October 1999




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM-23 | Rooms Canyon | Cottonwood Creek - Below Rooms |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | * 0.04 | 0.50 |
| EW-10/1999 | 0.002 | 0.03 | 0.35 | 0 | 0.26 | 0 | 0.45 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 85.5 GPM/0.19 CFS

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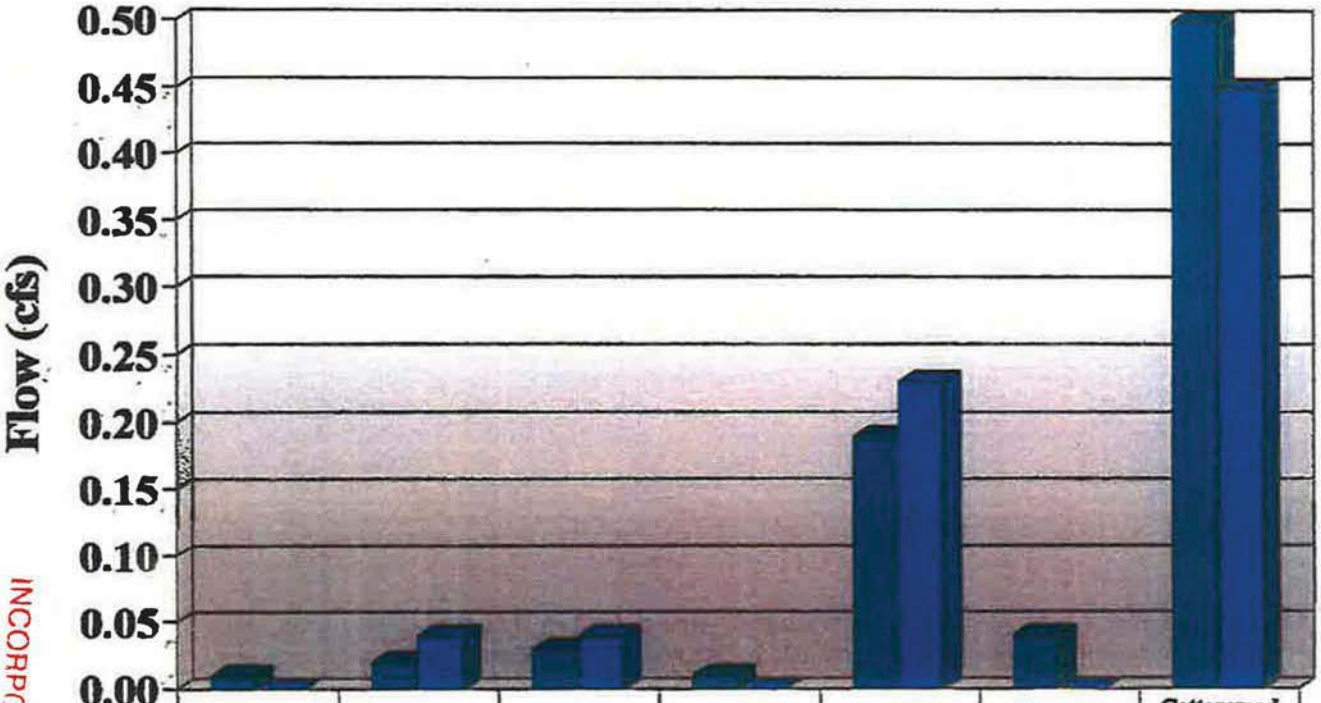
# Cottonwood Canyon Creek

## Flow Data Comparison

## USGS August 1979* Energy West November 1999




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM-23 | Roans Canyon | Cottonwood Creek - Below Roans |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | 0.04 | 0.50 |
| EW-11/1999 | 0 | 0.04 | 0.04 | 0 | 0.23 | 0 | 0.45 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 98.89 GPM/0.22 CFS

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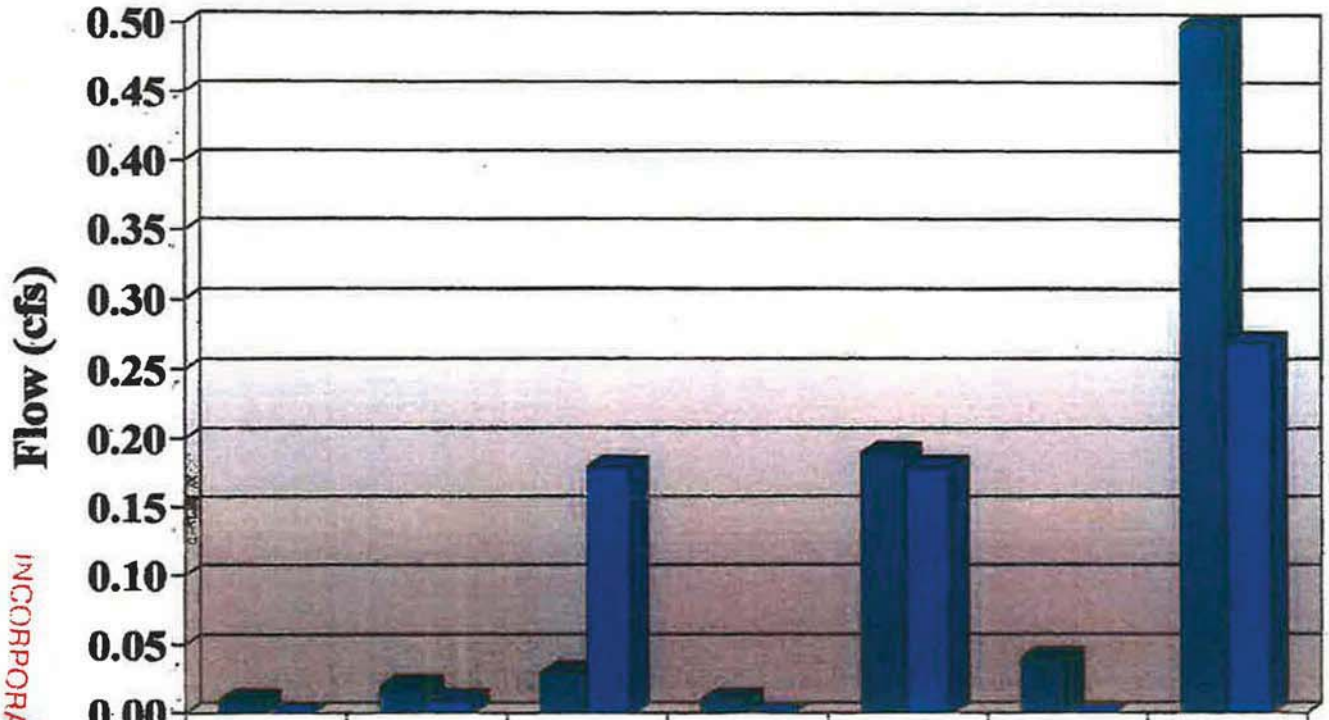
# Cottonwood Canyon Creek

## Flow Data Comparison

## USGS August 1979* Energy West June 2000




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM-23 | Roans Canyon | Cottonwood Creek - Below Roans |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | 0.04 | 0.50 |
| EW-06/2000 | 0 | 0.01 | 0.18 | 0 | 0.18 | 0 | 0.27 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 39.7 GPM/0.09 CFS

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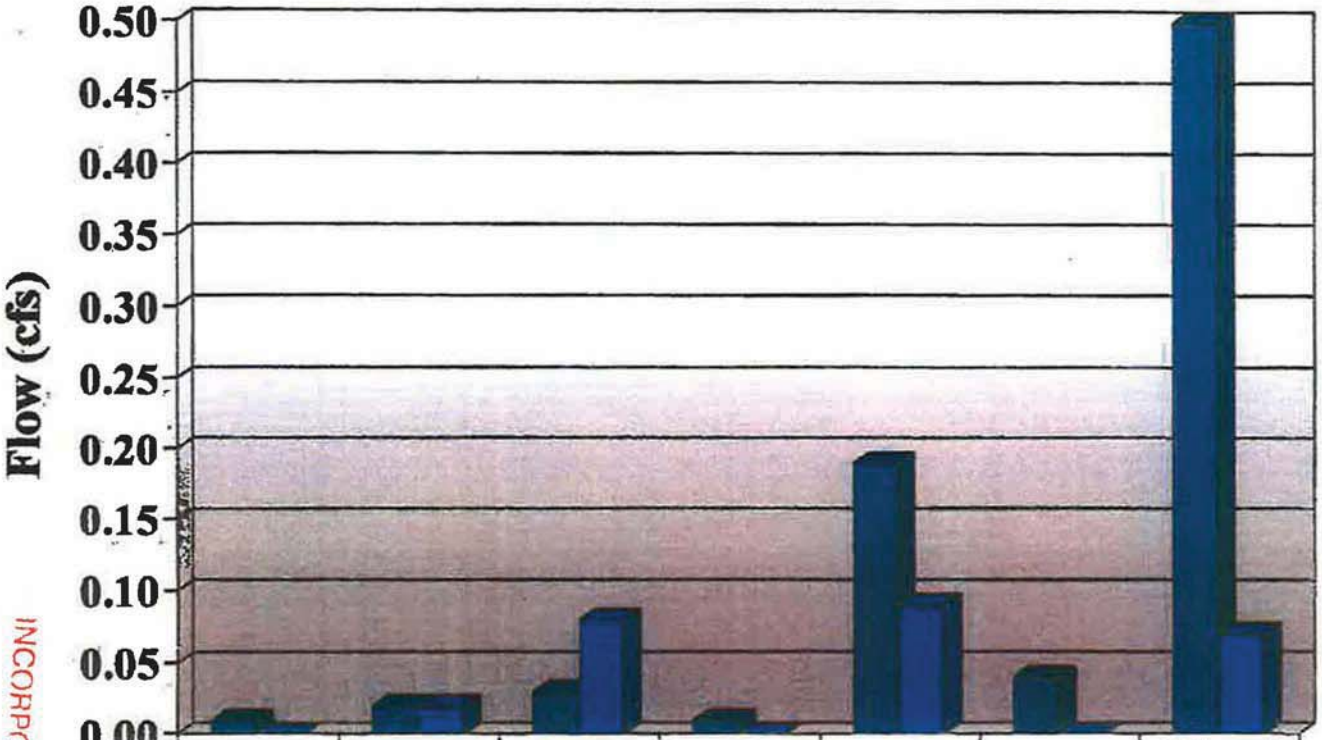
# Cottonwood Canyon Creek

## Flow Data Comparison

## USGS August 1979* Energy West October 2000




| | @ Mill Canyon | Dairy Canyon | @91-72 | Trail Canyon | Cottonwood Creek-TM-23 | Roans Canyon | Cottonwood Creek - Below Roans |
|---|---|---|---|---|---|---|---|
| USGS-1979 | 0.01 | 0.02 | 0.03 | 0.01 | 0.19 | 0.04 | 0.50 |
| EW-10/2000 | 0 | 0.02 | 0.08 | 0 | 0.09 | 0 | 0.07 |

* USGS Open File Report 81-539

Cottonwood Spring Area Flow = 0.0 GPM/0.0 CFS

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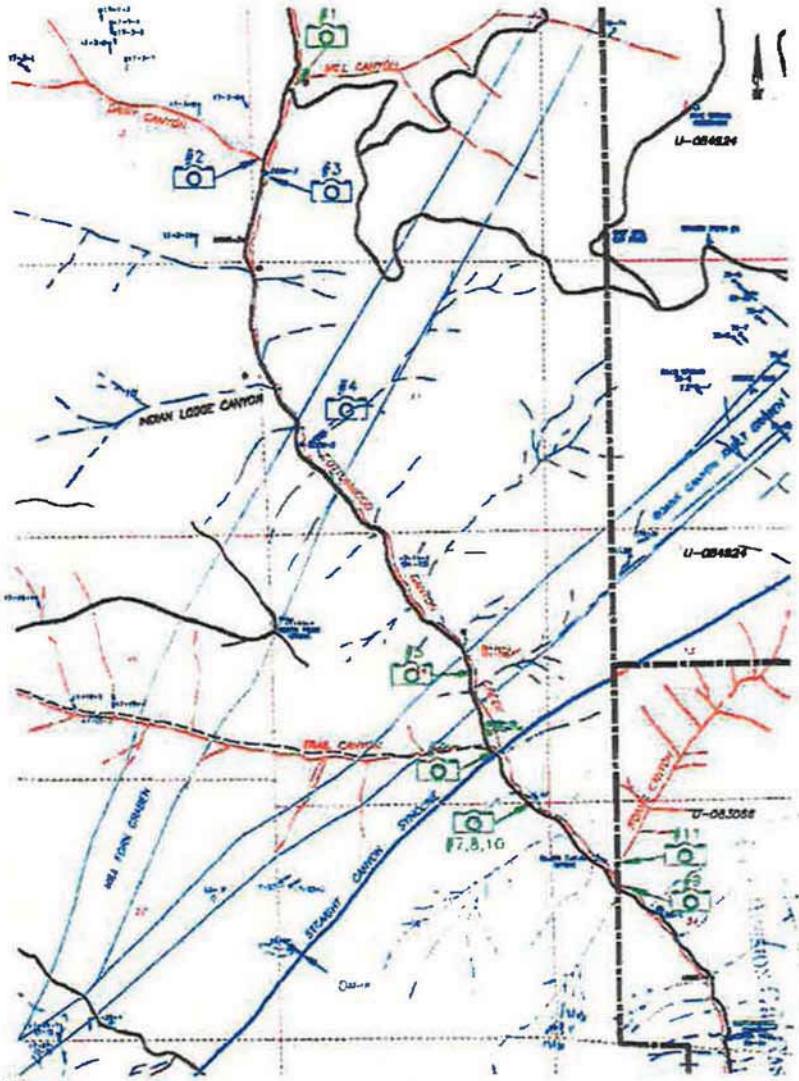


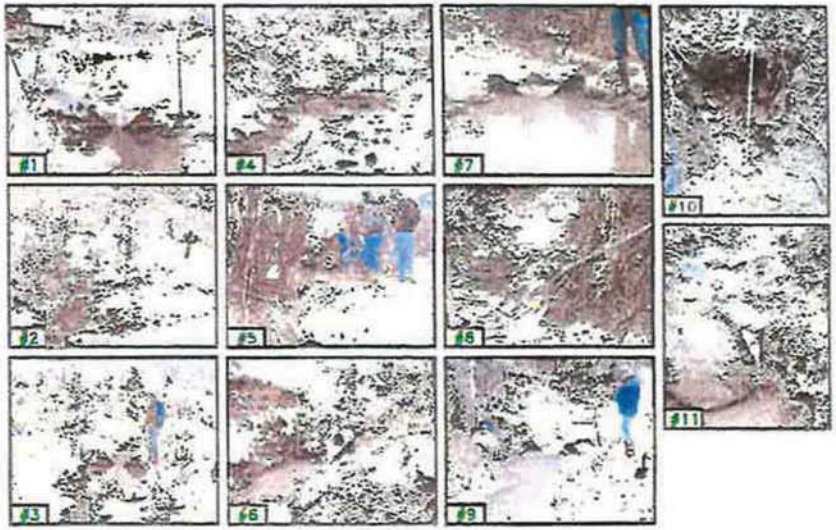


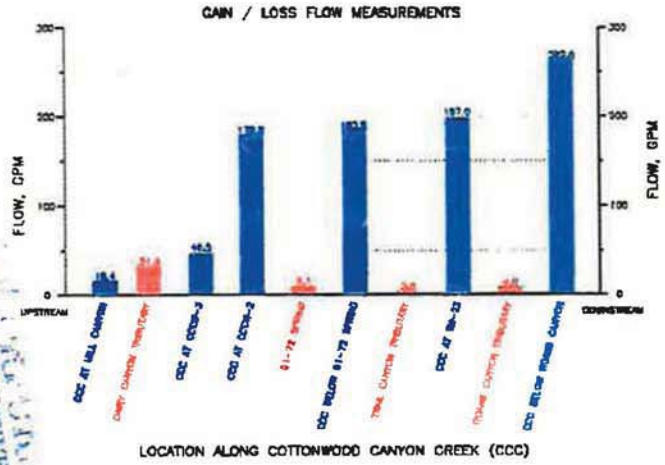


LEGEND

#1 PHOTOGRAPH LOCATION

Main Stream Drainage (Red)

Water Producing Tributary (Red)

Dry Tributaries (Blue)

DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY NOVEMBER 10, 1998

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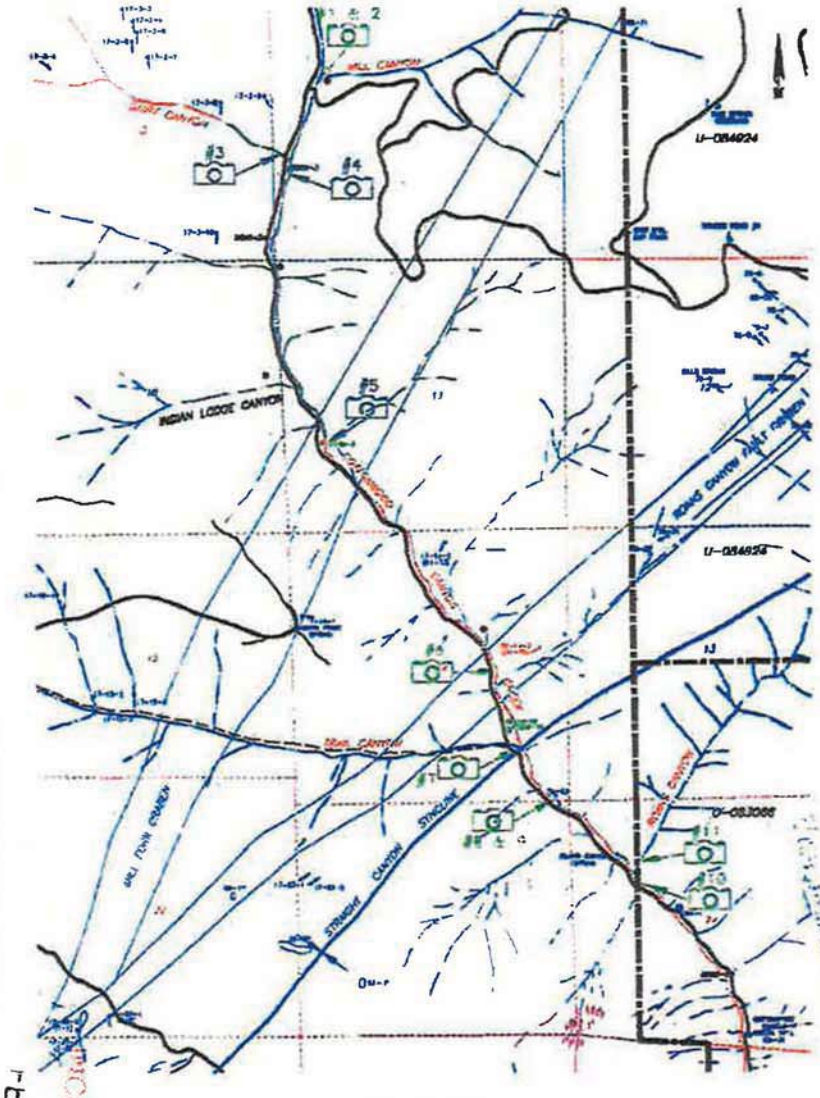


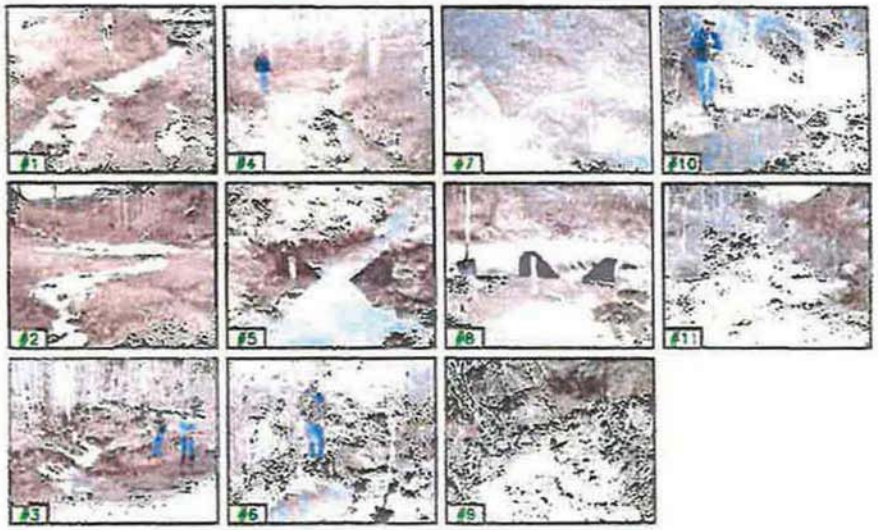


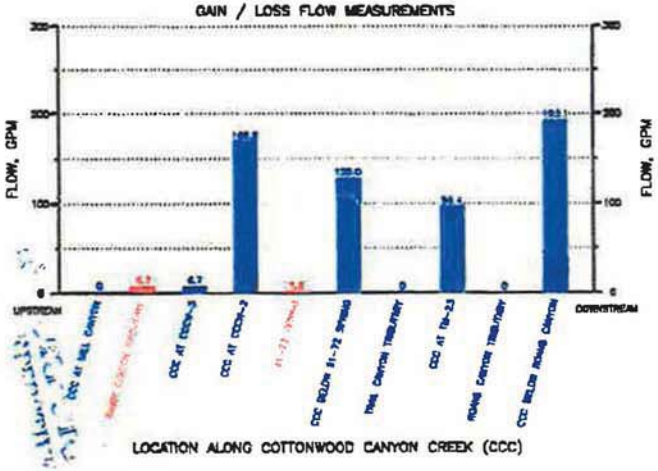


LEGEND

PHOTOGRAPH LOCATION

Main Stream Drainage (Red)

Water Producing Tributary (Red)

Dry Tributaries (Blue)

DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY MARCH 28, 1995

GEN31778D

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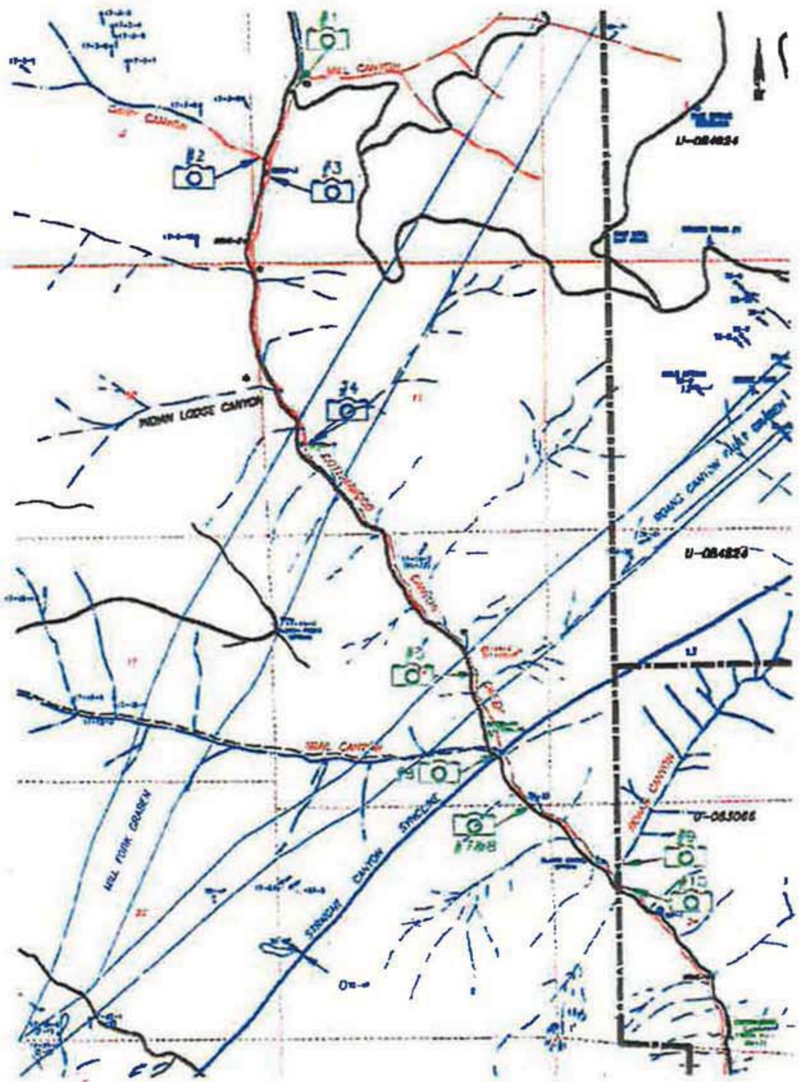
& Mining

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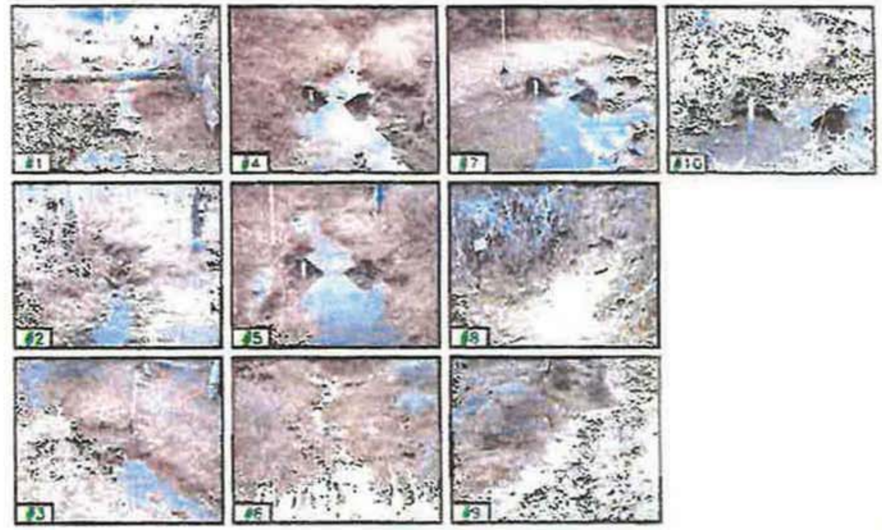


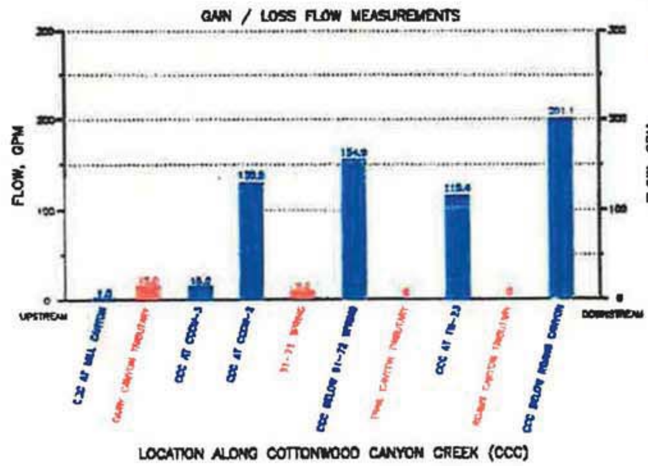


LEGEND

#1

PHOTOGRAPH LOCATION

Main Stream Drainage (Red)

Water Producing Tributary (Red)

Dry Tributaries (Blue)

DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY OCTOBER 6, 1999

GEN81781D

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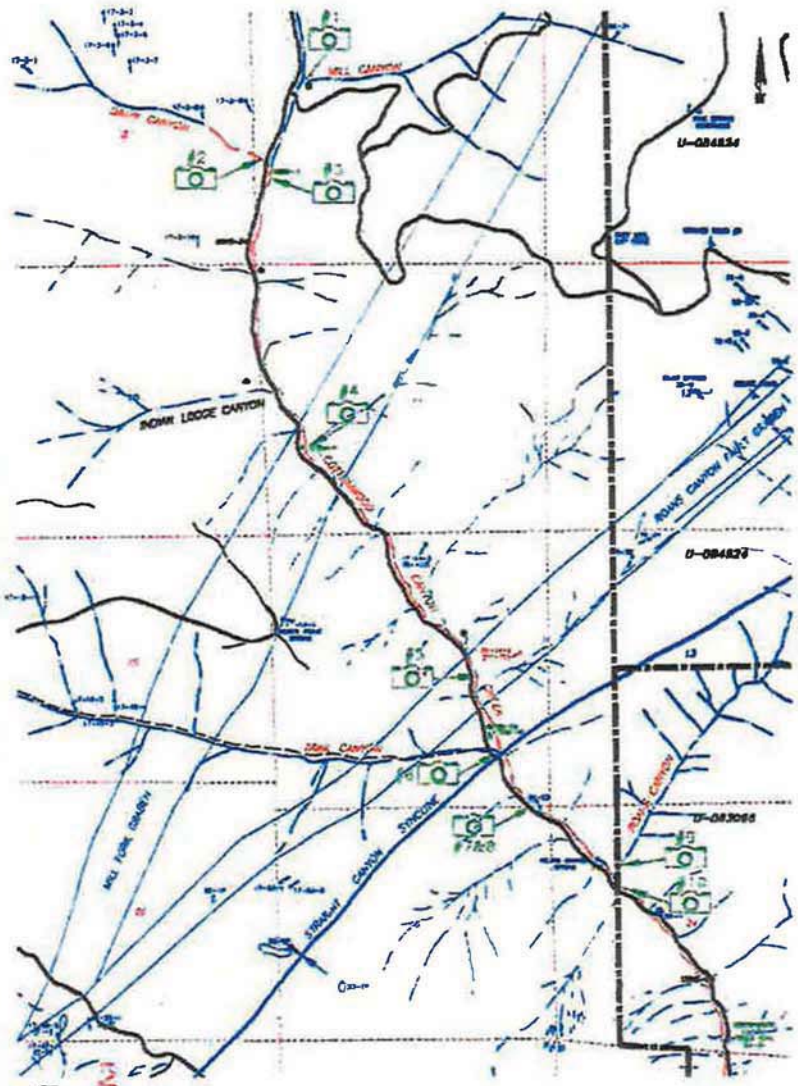
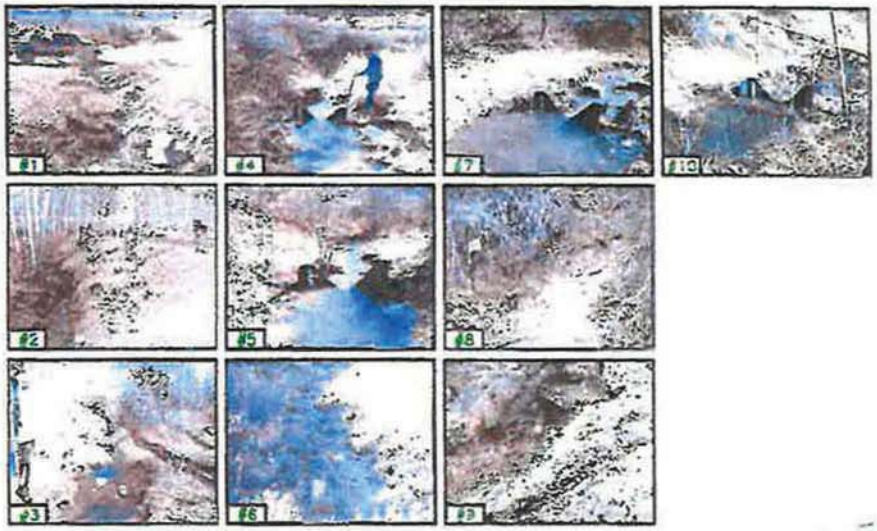
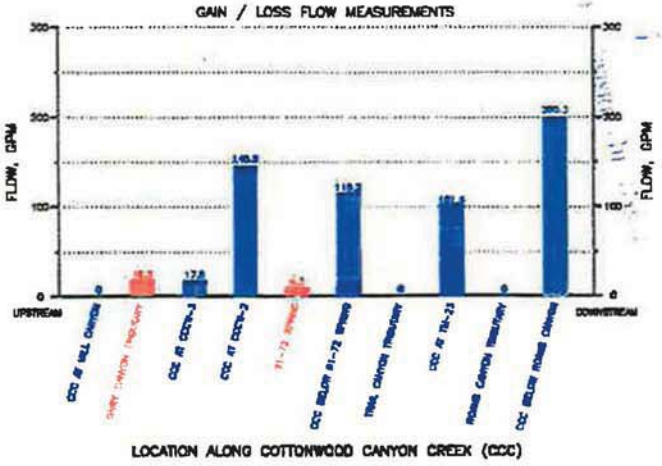
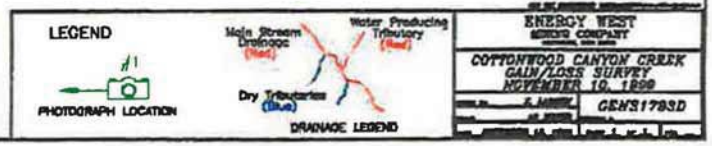
OGD

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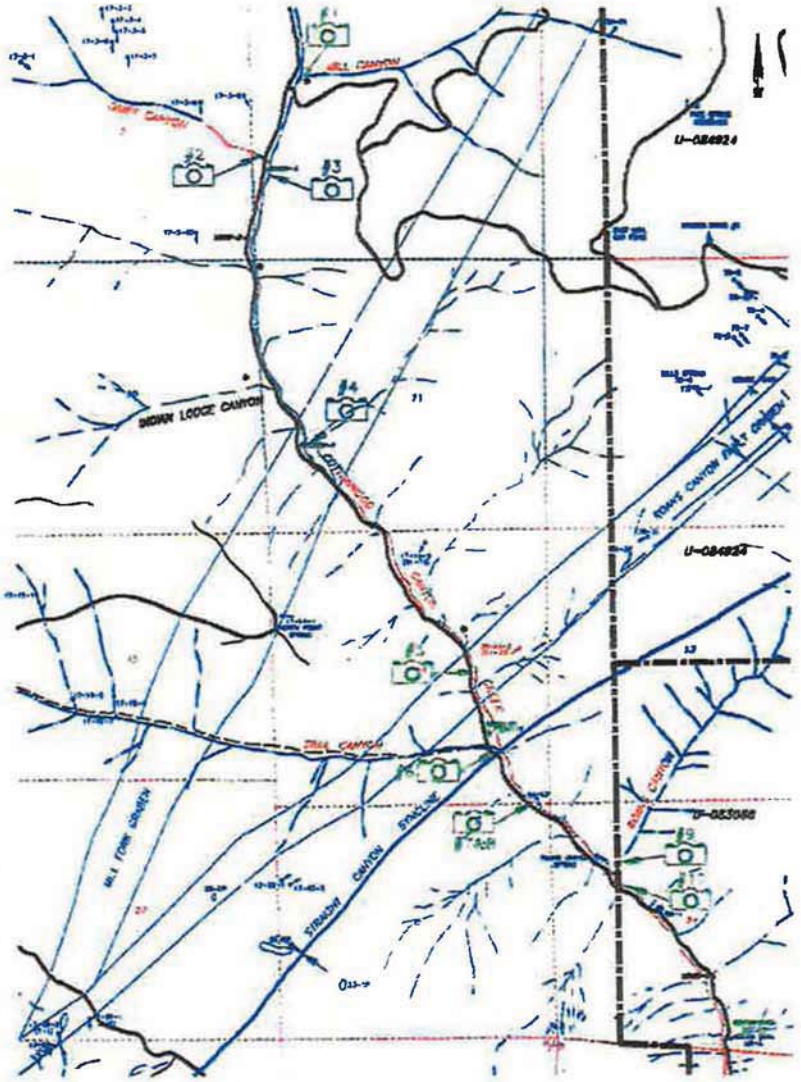


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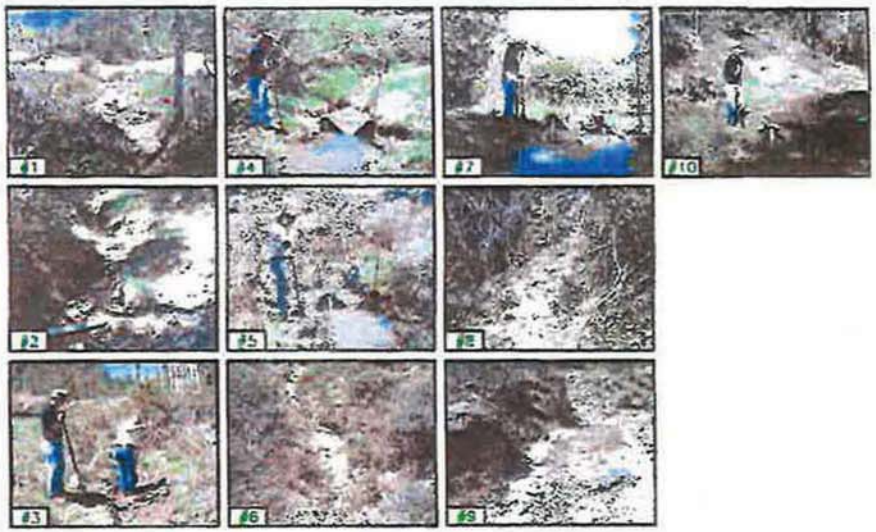

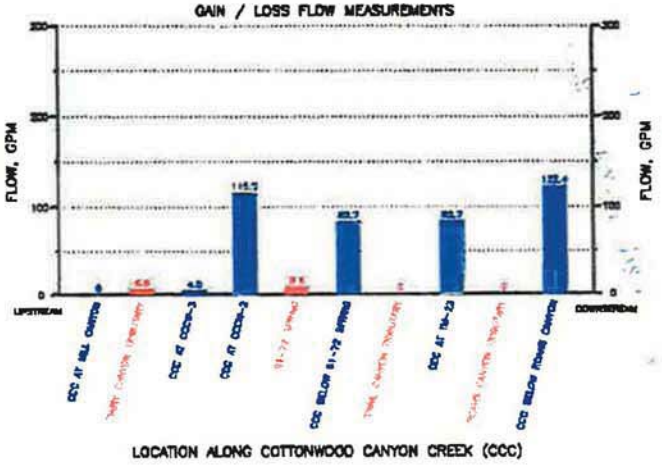


LEGEND

#1 PHOTOGRAPH LOCATION

Main Stream Drainage (Red)
Water Producing Tributary (Red)
Dry Tributaries (Blue)
DRAINAGE LEGEND

ENERGY WEST MINING COMPANY

COTTONWOOD CANYON CREEK GAIN/LOSS SURVEY JUNE 8, 2000

CENS1783D

FEB 02 2015

INCORPORATED

Mining

APPENDIX 7-18

SPLASH APRON DIAGRAM

# APPENDIX 7-18
# SPLASH APRON DIAGRAM

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JUN 27 2018

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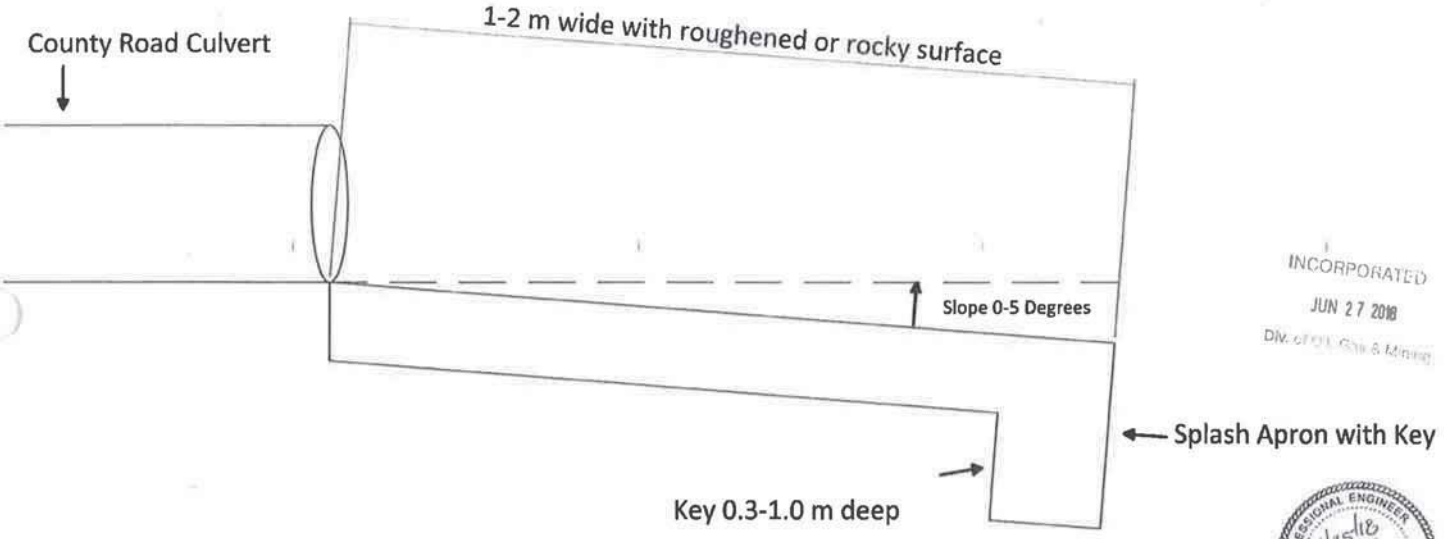


INCORPORATED
JUN 27 2018
DIV. OF OIL, Gas & Mining

PROFESSIONAL ENGINEER
6/25/18
NO. 9023281
JACOB B. SMITH
STATE OF UTAH

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Appendix 7-18 | Fossil Rock Resources, LLC<br>Fossil Rock Mine<br>597 South SR 24 - Salina, UT 84654<br>(435) 286-4880 Phone<br>(435) 286-4499 Fax | Cottonwood Mine Discharge Water Catchment<br>Detail of Splash Apron with Scour Cutoff Key | | | | REVISIONS | | | | SHEET NO. |
| | | SCALE: | DATE: 6/23/17 | DRAWN BY: BB | ENGINEER: BB | NO. | DATE | RCD. BY | ENG. BY | REMARKS | Sheet 1 |
| | | | | | CHECKED BY: JS<br>PROJ: | | | | | | |

# CHAPTER 8

# BONDING AND INSURANCE

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# CHAPTER 8
# BONDING AND INSURANCE

## 810 Bonding Definitions and Division Responsibilities

This chapter provides information regarding the bonding for coal mining and reclamation operations at the Mine. The applicant has on file with the UDOGM a bond or bonds made payable to the UDOGM for performance of all the requirements of the State Program.

## 820 Requirement to File a Bond

The area covered by the bond is outlined on Plates 5-2, 5-14A and B which cover the disturbed areas. The disturbed areas and specific acres to be reclaimed are listed in Section 115. The performance bond period is for the duration of the coal mining and reclamation operations including the extended period designated by the UDOGM. The bond is in the form of a surety bond and is described in Section 860.

## 830 Determination of Bond Amount

The present bond should be sufficient to assure the completion of the reclamation plan. The estimated cost to reclaim the SUFCO Mine surface facilities is provided in Appendix 5-1. However, if an adjustment in the bond coverage is necessary, the amount will be increased/decreased per the UDOGM's requirements.

## 840 General Terms and Conditions of the Bond

The performance bond is in the amount determined by the UDOGM as described in Section 830 and payable to the UDOGM. In the event the surety company becomes insolvent, the UDOGM will be notified by the permittee. The surety company and permittee will notify the UDOGM of any changes in the bonding terms for Canyon Fuel Company LLC, Fossil Rock Mine. Duration of the bond is described in Section 820.

## 850 Bonding Requirements for Underground Coal Mining and Reclamation Activities and Associated Coal-Related Surface Facilities

The applicant qualifies for a long-term period of liability and therefore will comply with the stipulation that the bond coverage be extended 30 days prior to the expiration of the bond term. A performance bond for a new term will be submitted to the UDOGM prior to expiration of coverage.

## 860 Forms of Bonds

The surety bond for the applicant has been executed per the documentation within the reclamation agreement. The surety bond will be non-cancellable during its term except with the prior consent of the Division of Oil, Gas and Mining (UDOGM).

## 870 Replacement of Bonds

Fossil Rock Mine does not currently plan to replace the bond for the permit area. However, should a replacement bond be required, the replacement bond will be submitted to and approved by the UDOGM prior to the cancellation of the original bond.

## 880 Requirements to Release Performance Bonds

The applicant will comply with the requirements described in Section R645-301-880 of the UDOGM regulations when applying for the release of performance bonds.

## 890 Terms and Conditions for Liability Insurance

Certificates of Insurance issued to Canyon Fuel Company LLC, Fossil Rock Mine are submitted to the Division upon renewal. The policy provides for personal injury and property damage protection concurrent with the amounts designated in R645-301-890.100. Said Certificates of Insurance are applicable to coal mining and reclamation operations as proposed in the Fossil Rock Mine M&RP.

The insurance policy will be maintained in full force during the life of the permit including the liability period necessary to complete all reclamation operations. The policy will include a rider stating that the UDOGM be notified of any changes in the policy including termination or failure to renew.

# CHAPTER 9

# ALLUVIAL VALLEY FLOOR

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322 Operations Affecting Designated Alluvial Valley Floor ..... 9-3

# ALLUVIAL VALLEY FLOORS

## 320 Alluvial Valley Floors

All coal mining operations must provide to the UDOGM a determination that the regulations of R645-302-320 do not apply.

### 321 Alluvial Valley Floor Determination

This Alluvial Valley Floor (AVF) determination includes field investigations of geologic, hydrologic, land use, soils, and vegetation for all areas where the mine permit or adjacent areas have a valley holding a stream. Refer to Section 724.400 for additional information.

#### 321.200 Studies Performed During Investigation

The studies for AVF determination may include:

- Mapping of unconsolidated stream-laid deposits of areas holding streams, including but not limited to geologic maps of unconsolidated deposits and stream-laid deposits, maps of streams, delineation of surface watersheds and directions of shallow groundwater, topography showing local and regional terrace levels, and topography of terraces, flood plains, and channels showing surface drainage patterns;
- Mapping of all lands included in the permit and adjacent area subject to agricultural activities, showing the areas of different types of agricultural lands, such as flood irrigated lands, pasture lands, and undeveloped rangelands. Also, the productivity measurements for each vegetative type should be included;
- Mapping of all lands that currently are or were historically flood irrigated, showing the location of each diversion structure, ditch, dam, and related reservoir, irrigated land, and topography of those lands;

- o Identification of areas which are or are not subirrigated, based on groundwater monitoring data, representative water quality, soil moisture measurements, and measurements of rooting depth, soil mottling, and water requirements of vegetation;
- o Identification of areas which are or are not flood irrigable, based on stream flow, water quality, water yield, soils measurements, and topographic characteristics; and
- o Analysis of a series of aerial photographs, including color infrared imagery flown at a time of year to show any late summer and fall differences between upland and valley floor vegetative growth.

**321.300 Determination of Alluvial Valley Floor Existence**

Based on these studies, the UDOGM will determine that an AVF exists if it finds that:

- o Unconsolidated stream laid deposits holding streams are present; and,
- o There is sufficient water to support agricultural activities as evidenced by:
  - The existence of flood irrigation in the area in question or its historical use;
  - The capability of an area to be flood irrigated, based on stream flow water yield, soils, water quality, and topography; or,
  - Subirrigation of the lands in question, derived from the groundwater system of the valley floor.

As shown on Plate 5-2, 5-4 and 7-5 the mine permit area consists of plateaus and deep canyons. Evaluation of the mine permit area and UDOGM rules for AVF's show:

1. Unconsolidated stream laid deposits holding streams are present in the Lower Cottonwood Canyon area. Adjacent to the mine site the drainage is deep and very steep and is narrow at the bottom. Stream laid deposits are present only in small, discontinuous narrow patches. Bedrock is exposed in much of the canyon bottom and the stream cascades over exposed bedrock outcrops.

2. There is no flood irrigation in the immediate mine plan area or the adjacent area and no

evidence of historical use of flood irrigation. Due to small size, steepness, water availability, land ownership, and short growing season, these areas are not practical for flood irrigation.

In this region, flood irrigation is not practiced in such high mountain drainages. In the cultivated lands along the creek in Straight Canyon which lies approximately 5 miles south of the mine site, flood irrigation may have been historically done. However current observations have shown the fields being irrigated with sprinkler systems.

### 322 Operations Affecting Designated Alluvial Valley Floor

Based on hydrology and geology of the mine permit area and the adjacent area, there appear to be no alluvial valley floors in the area. A possible AVF exists in the general area along the Creek in Straight Canyon downstream of the mine site.

T. 16 S.
T. 17 S.
R. 6 E.
R. 7 E.
FRR FEE
UTU-49332
UTU-64375
UTU-082996

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY
- 20 SOIL ZONES

NOTE: DATA FROM COTTONWOOD CANYON EIS

| MAP UNIT | FAMILY-COMPLEX |
|---|---|
| 8 | Greyback family-Cryorthents complex |
| 20 | Strych-Pathead-Podo families-Rubbleland complex |
| 23 | Trag-Curecanti families complex |
| 24 | Rabbitex-Repp-Reva families complex |
| 25 | Frandsen-Allens Park-Repp families complex |
| 41 | Castino family |
| 100 | Gralic-Behanin-Elwood families complex |
| 107 | Curecanti-Elwood-Duchesne families complex |
| 402 | Roxal-Merino-Gralic families complex |
| 411 | Clayburn-Faim families complex |
| 560 | Clayburn-Broad Canyon families |
| 561 | Clayburn-Faim-Behanin families complex |
| 700 | Heliotrope(t)-Willow Lake(t)-Dateman families complex |
| 820 | Lucky Star-Bundo-Adel families complex |

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/08/2020 | VSM | JKS | |

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: 24X36 SHEET
PROJECT NUMBER: ####

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

SOILS
PLATE 2-1

| SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|
| 1" = 1,200' | 9/16/2019 | A.B.E. | A.B.E. | X.X.X. | 2-1 |

FILE NAME: Plate 2-1 Soils

SSlaughter: 4/15/2020 6:33 AM

T. 16 S.
T. 17 S.

R. 6 E.
R. 7 E.

UTU–64375

UTU–49332

FRR FEE

UTU–082996

N

Aspen Woodland

Barren

Mountain Brush

Pinyon Juniper Woodland

Forb Meadow

Sagebrush/Grassland

Riparian

Mixed Conifer

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY

NOTE: DATA FROM COTTONWOOD CANYON EIS

SSlaughter: 4/15/2020 6:35 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/08/2020 | VSM | JKS | |

PEN TBL: _1Stndrd–SUFENP1.ctb
SHT SET: 24X36 SHEET
PROJECT NUMBER: ####

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

VEGETATION
PLATE 3–1

| SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|
| 1" = 1,200' | 9/16/2019 | A.B.E. | A.B.E. | X.X.X. | 3–1 |

FILE NAME: Plate 3–1 Vegetation

T. 16 S.
T. 17 S.

R. 6 E.
R. 7 E.

UTU-64375

UTU-49532

UTU-082996

FRR FEE

## LEGEND

- Deer Summer Range High Priority
- Deer Winter Range High Priority
- Deer Winter Range Critical
- Elk Summer Range High Priority
- Elk Winter Range High Priority
- Elk Winter Range Critical

N

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY

NOTE: DATA FROM COTTONWOOD CANYON EIS

SSlaughter: 4/15/2020 6:36 AM

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/08/2020 | VSM | JKS | |

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: 24X36 SHEET
PROJECT NUMBER: ####
FILE NAME: Plate 3-2 DEER AND ELK RANGE

Fossil Rock Resources, LLC
Fossil Rock Mine
597 South SR 24 - Salina, UT 84654

# DEER AND ELK RANGE
# PLATE 3-2

| SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|
| 1" = 1,200' | 04/03/2020 | JKS | A.B.E. | X.X.X. | 3-2 |

T. 16 S.
T. 17 S.
R. 6 E.
R. 7 E.
UTU-49332
UTU-64375
UTU-082996
FRR_FEE
N

# Fossil Rock Resources, LLC
## Fossil Rock Mine
597 South SR 24 - Salina, UT 84654

**BAT HABITAT**
**PLATE 3-5**

| | | |
|---|---|---|
| SCALE: 1" = 3,000' | DATE: 09/17/2019 | DRAWN BY: A.B.E |
| ENGINEER: X.X.X. | CHECKED BY: X.X.X. | SHT: 11X17 SHEET |
| FILE NAME: Plate 3-5 – Bat Habitat | | |

SHEET NO.
3-5

SSlaughter: 4/15/2020 6:41 AM

FOREST SERVICE BOUNDARY MARKER

FOREST SERVICE BOUNDARY MARKER

COTTONWOOD CREEK

VEGETATION/ROCK
0.04 ACRES
B.T.C.A. AREA

CULVERT INLET

BERM

TOPSOIL

EMERY COUNTY ROAD

SMALL AREA EXEMPTION

VEGETATION/ROCK
0.21 AC
B.T.C.A. AREA

PERMIT BOUNDARY
17.97 AC

DISTURBED AREA BOUNDARY 10.39 AC

COTTONWOOD CREEK

N

## LEGEND

| | |
|---|---|
| PERMIT BOUNDARY | REVEGETATED AREAS |
| DISTURBED AREA BOUNDARY | SMALL AREA EXEMPTION |
| B.T.C.A. BEST TECHNOLOGY CURRENTLY AVAILABLE | ROCK/RIPRAP |
| | VEGETATION/ROCK |

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/08/2020 | VSM | JKS | |

Fossil Rock Resources, LLC
Fossil Rock Mine
597 South SR 24 - Salina, UT 84654

# CONTEMPORANEOUS RECLAMATION
# PLATE 3-6

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 100' | 9/17/2019 | A.B.E. | A.B.E. | X.X.X. | 3-6 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 3-6 CONTEMP RECLAMATION | | | | |

SSlaughter 4/15/2020 6:42 AM

T. 16 S.
T. 17 S.
T. 17 S.
T. 18 S.
R. 6 E.
R. 7 E.
Water Creek
Lowry
Indian Creek
Cottonwood Creek
Water
Lowry
Creek
JOES VALLEY RESERVOIR
HWY 29
SPORTSMAN LODGE
JOES VALLEY OVERLOOK
UTU-64375
UTU-049332
UTU-082996
PERMIT BOUNDARY
8800
9000
9800
10000
9600
8000
7000
6400
50034
50304
50060
50040
52302
50914
52181
52180

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED
- TRAIL

## LAND USE

- GAS WELL
- GAS WELL ABANDONED
- GAS PIPELINE
- EAST MOUNTAIN OIL AND GAS UNIT
- GENERAL AREA LAND USES INCLUDE GRAZING, WILDLIFE HABITAT, HUNTING, AND RECREATION
- INDUSTRIAL/MINING

SSlaughter 4/15/2020 6:43 AM

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/08/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

PREMINING LAND USE
PLATE 4-1

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 9/18/2019 | A.B.E. | A.B.E. | X.X.X. | 4-1 |

| SHT SET: | PROJECT NUMBER: | FILE NAME: |
|---|---|---|
| 24X36 SHEET | #### | Plate 4-1 Premining Land Use |

T. 16 S.
T. 17 S.
T. 17 S.
T. 18 S.
R. 6 E.
R. 7 E.
Water Creek
Indian Creek
Lowry
Cottonwood Creek
Water
Lowry
JOES VALLEY RESERVOIR
Cottonwood Creek
FRR FEE
UTU-64375
UTU-049332
UTU-082996
SPORTSMAN LODGE
JOES VALLEY OVERLOOK
HWY 29
50034
50304
50060
50040
52302
50314
52181
52180
8800
9000
9800
10000
9600
8000
7000
6400

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED
- TRAIL

## LAND USE

- GAS WELL
- GAS WELL ABANDONED
- GAS PIPELINE
- EAST MOUNTAIN OIL AND GAS UNIT
- GENERAL AREA LAND USES INCLUDE GRAZING, WILDLIFE HABITAT, HUNTING, AND RECREATION

SSlaughter 4/15/2020 6:45 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/08/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# POSTMINING LAND USE
# PLATE 4-2

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 9/18/2019 | A.B.E. | A.B.E. | X.X.X. | 4-2 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 4-2 Postmining Land Use | | | | |

EAST MOUNTAIN
CATTLE ALLOTMENT
Considered Unsuitable Range

CATTLE AND HORSE
ALLOTMENT AREA

CLOSED TO GRAZING

T. 16 S.
T. 17 S.

T. 17 S.
T. 18 S.

R. 6 E.
R. 7 E.

COTTONWOOD CREEK

JOES VALLEY RESERVOIR

HWY 29

UTU-049332

UTU-64375

UTU-082996

FRR FEE

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED

## GRAZING

- STOCK TROUGH
- STOCK POND
- RANGE FENCE
- ALLOTMENT BOUNDARY
- CLOSED TO GRAZING

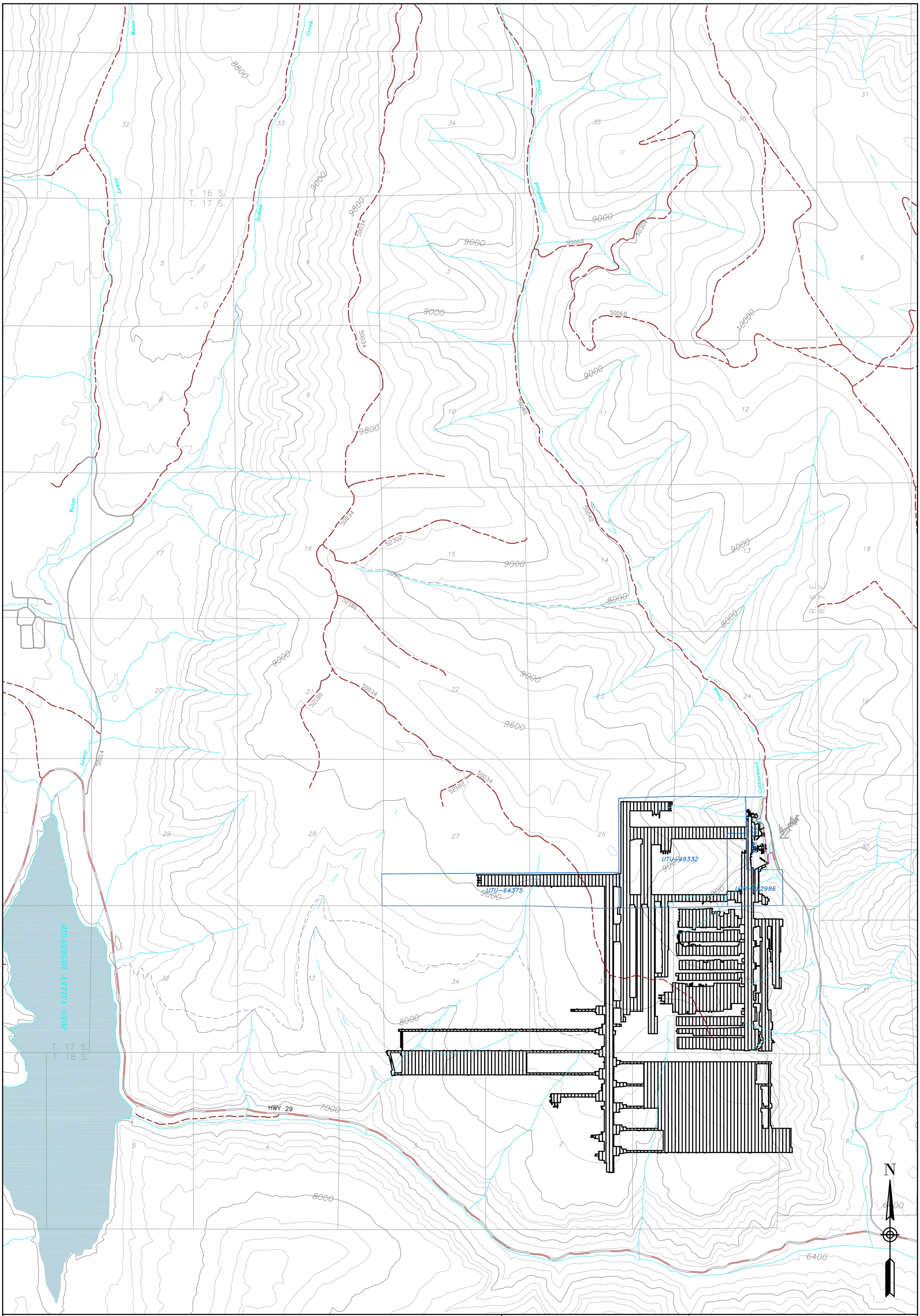
| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/02/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

GRAZING ALLOTMENTS
PLATE 4-3

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 9/18/2019 | A.B.E. | A.B.E. | X.X.X. | 4-3 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 4-3 Grazing Allotments | | | | |

SSlaughter 4/15/2020 6:46 AM




## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED

## MINED AREAS

- TRAIL MOUNTAIN MINE
- JOHNSON MINE

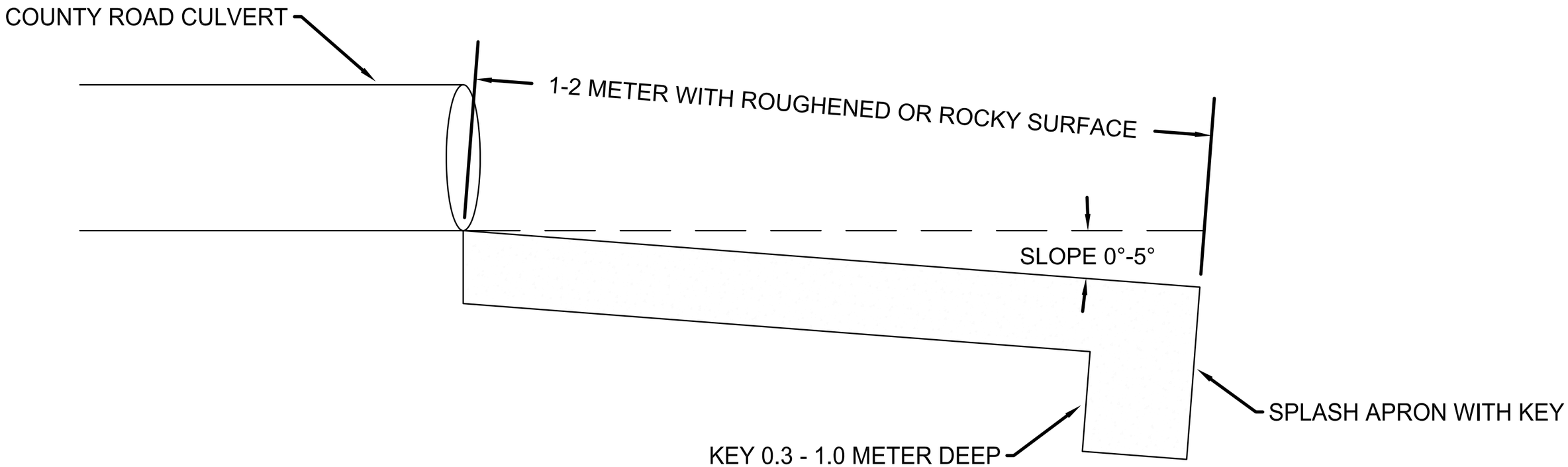
| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# PREVIOUSLY MINED AREAS
# PLATE 5-1

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 9/18/2019 | A.B.E. | A.B.E. | X.X.X. | 5-1 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 5-1 Previously Mined Areas | | | | |

SSlaughter 4/15/2020 6:47 AM




SSlaughter: 4/15/2020 7:37 AM

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

**COTTONWOOD MINE DISCHARGE WATER CATCHMENT**

**DETAIL OF SPLASH APRON WITH SCOUR CUTOFF KEY**

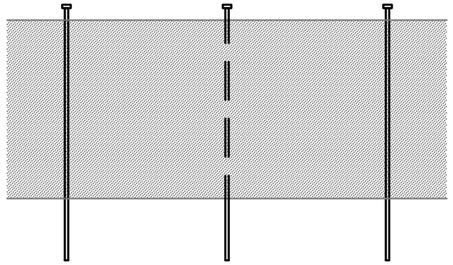
| SCALE: N.T.S | DATE: 09/23/2019 | DRAWN BY: A.B.E. | ENGINEER: X.X.X. | CHECKED BY: X.X.X. |
|---|---|---|---|---|
| FILE NAME: Plate 5–10 Splash Apron | | | | SHTS: 11X17 SHEET |

REVISIONS

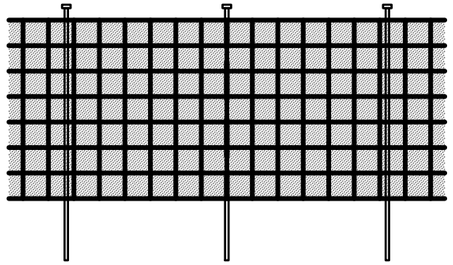
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

SHEET NO.

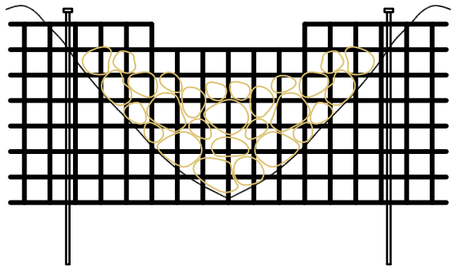
5–10



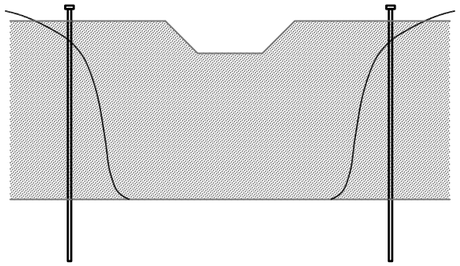
SILT FENCE
(SEDIMENT CONTROL/RUNOFF CONTROL
WIDTH AND HEIGHT VARIES)
BOTTOM KEYED IN TO PREVENT BYPASS
SIDES KEYED IN WHEN NECESSARY



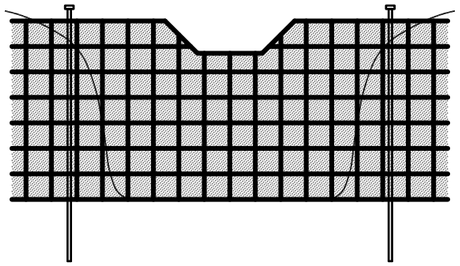
SILT FENCE & MESH
(SEDIMENT CONTROL/RUNOFF CONTROL
WIDTH AND HEIGHT VARIES)
BOTTOM KEYED IN TO PREVENT BYPASS
SIDES KEYED IN WHEN NECESSARY



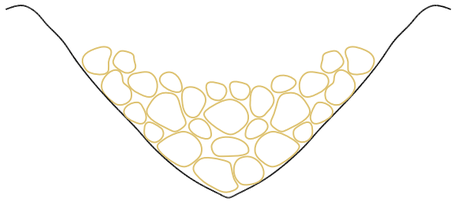
ROCK GABION
(SEDIMENT CONTROL/ENERGY DISSIPATER
WIDTH AND HEIGHT VARIES)



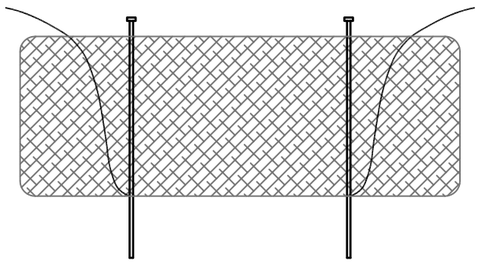
SILT FENCE OR OTHER FLOW
CONTROLLING DEVICE WITH NOTCH
(SEDIMENT CONTROL/RUNOFF CONTROL
WIDTH AND HEIGHT VARIES)
SIDES AND BOTTOM KEYED IN TO PREVENT
BYPASS



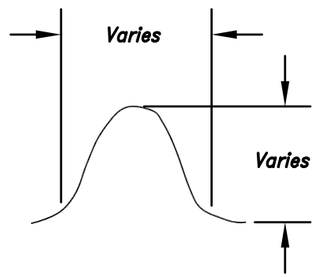
SILT FENCE & MESH WITH NOTCH
(SEDIMENT CONTROL/RUNOFF CONTROL WIDTH
AND HEIGHT VARIES)
SIDES AND BOTTOM KEYED IN TO PREVENT
BYPASS



ROCK GABION
(SEDIMENT CONTROL/ENERGY DISSIPATER
WIDTH AND HEIGHT VARIES)
WIRE MESH PLACED ON TOP OF ROCK WHEN
NECESSARY



STRAW BALE INSTALLATION
(SEDIMENT CONTROL/RUNOFF CONTROL
WIDTH AND HEIGHT VARIES)
SIDES AND BOTTOM KEYED IN TO PREVENT
BYPASS




DIRT BERM
(SEDIMENT CONTROL/RUNOFF CONTROL)

SSlaughter: 4/15/2020 7:38 AM

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

**FOSSIL ROCK MINE**

**TYPICAL ALTERNATIVE SEDIMENT CONTROL MEASURES**

| SCALE: 1" = 75' | DATE: 9/23/2019 | DRAWN BY: A.B.E. | ENGINEER: X.X.X. | CHECKED BY: X.X.X. |
|---|---|---|---|---|
| FILE NAME: Plate 5-11 Typ Sediment Control Measures | | | | SHTS: 11X17 SHEET |

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

SHEET NO.
5-11

COTTONWOOD CREEK

RIPRAP

BERM

0+00

2+00

BERM

4+00

RECLAIMED AREA

DISTURBED AREA RUNOFF

6+00

BERM

RESTORED CHANNEL

BERM

8+00

48" CMP

BERM

10+00

RECLAIMED AREA

12+00

14+00

BERM

16+00

96" TO 66" TRANSITION

SEDIMENT POND

RIPRAP

24" CMP

18+00

20+00

PRE 1977 DISTURBANCE AREA

PERMIT BOUNDARY
17.97 AC

22+00

DISTURBED AREA
BOUNDARY 10.39 AC

24+00

25+00

COTTONWOOD CREEK

25

N

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- PRE 1977 DISTURBANCE
- RESTORED CHANNEL
- BERMS
- 16+00 CROSS SECTION STATION, SEE PLATES 5-14A AND 5-14B

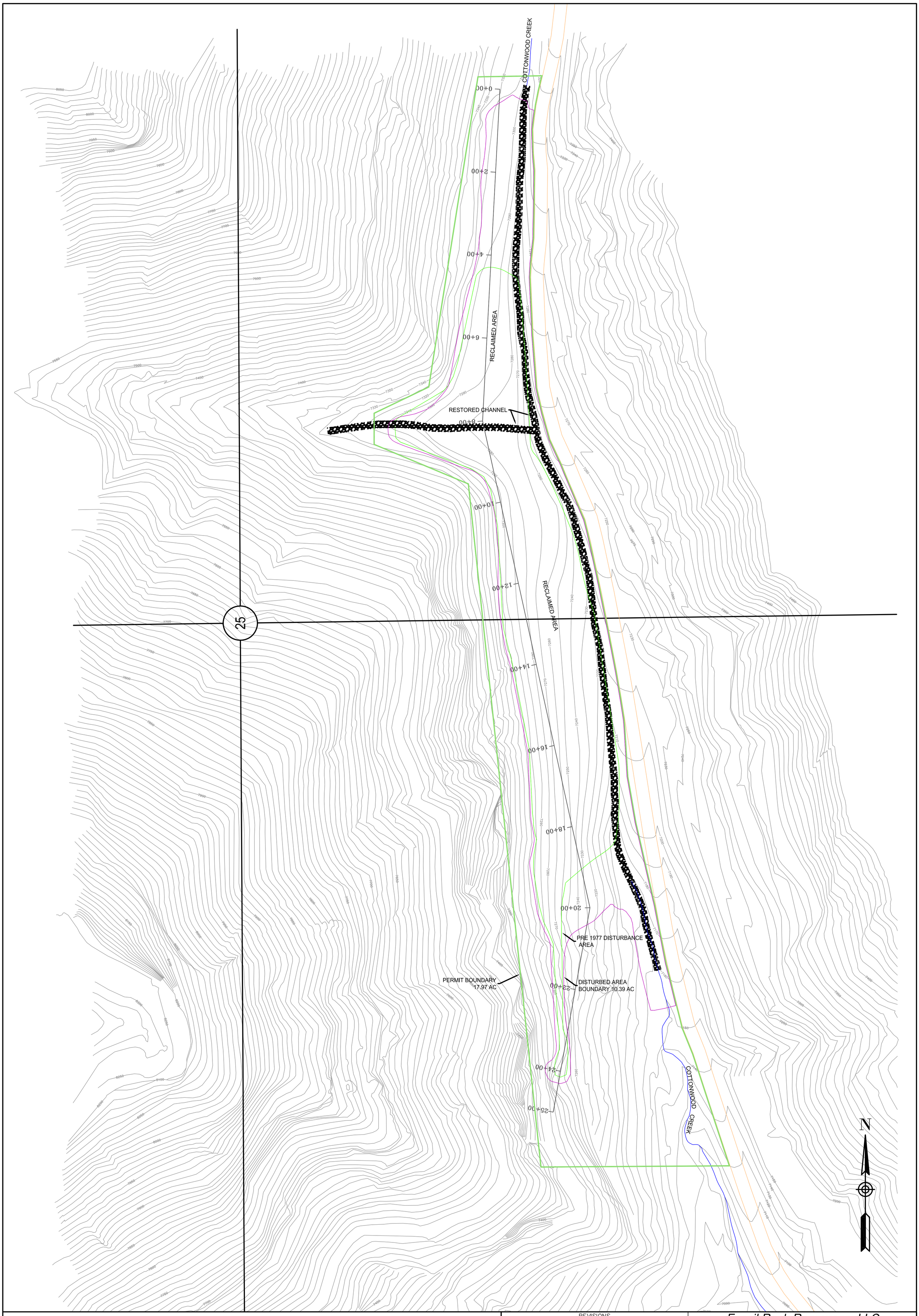
SSlaughter: 4/15/2020 7:40 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# POST MINE CONTOUR MAP
# RECLAMATION PHASE 1
# PLATE 5-12

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 100' | 9/23/2019 | A.B.E. | A.B.E. | X.X.X. | 5-12 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 5-12 Post Mine Cont Map Phase I | | | | |




## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- PRE 1977 DISTURBANCE
- RESTORED CHANNEL
- 16+00 — CROSS SECTION STATION, SEE PLATES 5-14C AND 5-14D

SSloughter: 4/15/2020 7:41 AM

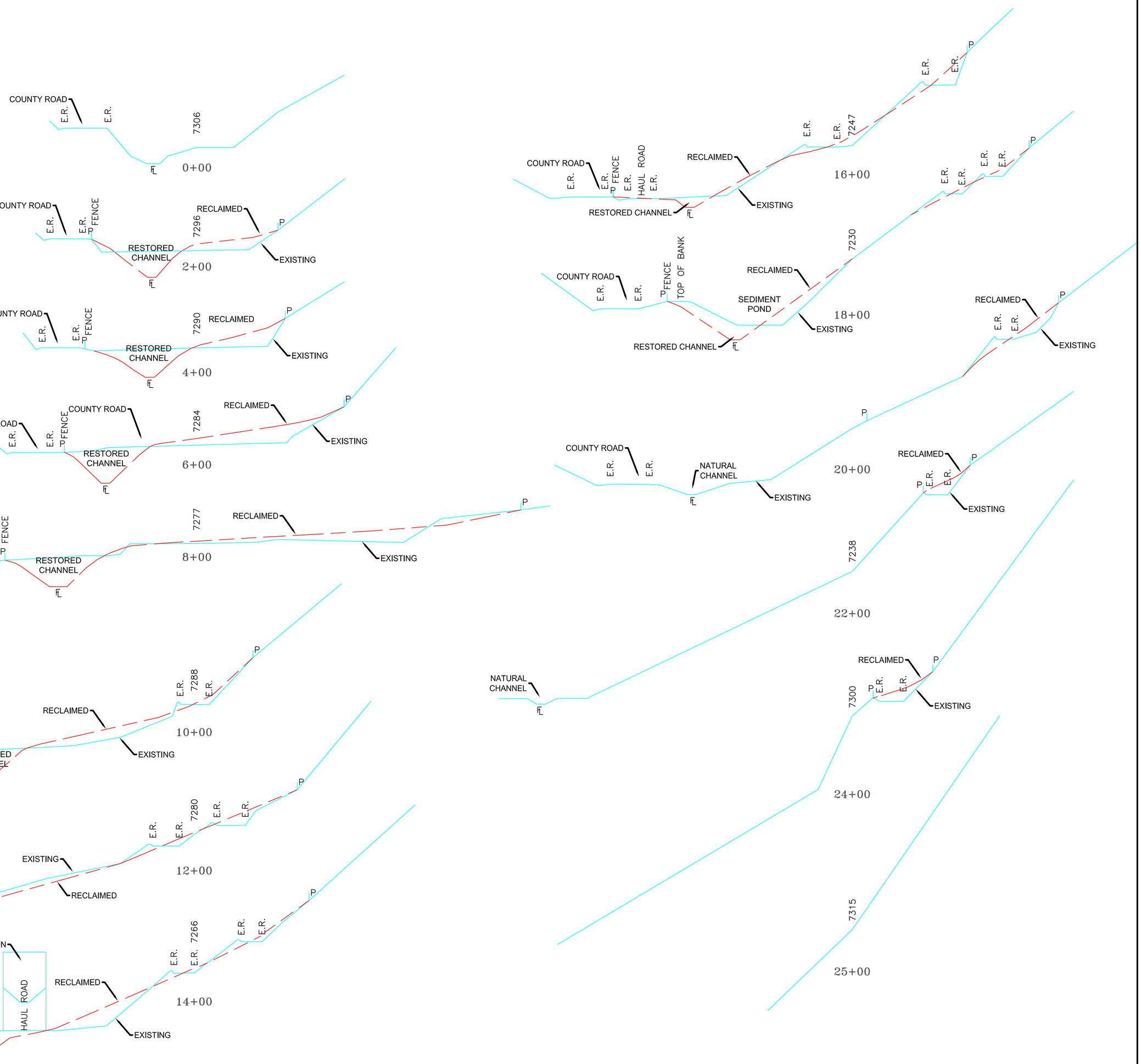
REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# POST MINE CONTOUR MAP
# RECLAMATION PHASE II
# PLATE 5-13

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 100' | 9/23/2019 | A.B.E. | A.B.E. | X.X.X. | 5-13 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 5-13 Post Mine Cont Map Phase II | | | | |




## LEGEND

| | |
|---|---|
| P | DISTURBED AREA BOUNDARY |
| E.R. | EDGE OF ROAD |
| FL | FLOW LINE |

SECTION LOCATIONS AND CONTOURS ARE SHOWN ON PLATE 5-12 PHASE 1.

SSlaughter: 4/15/2020 7:43 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

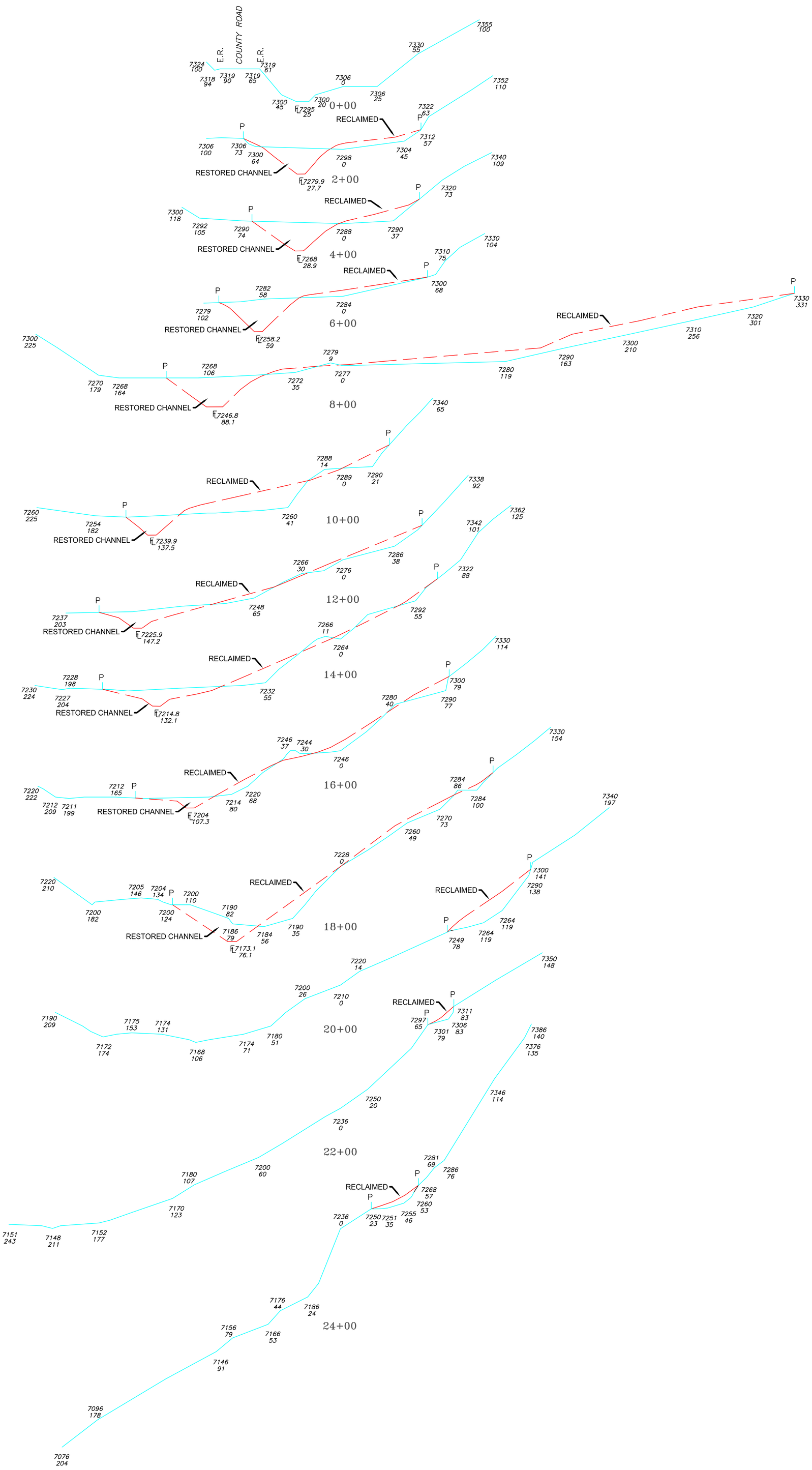
PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: 24X36 SHEET
PROJECT NUMBER: ####

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# EXISTING AND PHASE 1 RECLAMATION CROSS SECTIONS
## PLATE 5-14A

| SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|
| 1" = 40' | 9/24/2019 | A.B.E. | A.B.E. | X.X.X. | 5-14A |

FILE NAME: Plate 5-14A Phase I Rec Cross Sections




## LEGEND

| | |
|---|---|
| P | DISTURBED AREA BOUNDARY |
| E.R. | EDGE OF ROAD |
| ℄ | FLOW LINE |

SECTION LOCATIONS AND CONTOURS ARE SHOWN ON PLATE 5-13 PHASE 2.

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: 24X36 SHEET
PROJECT NUMBER: ####

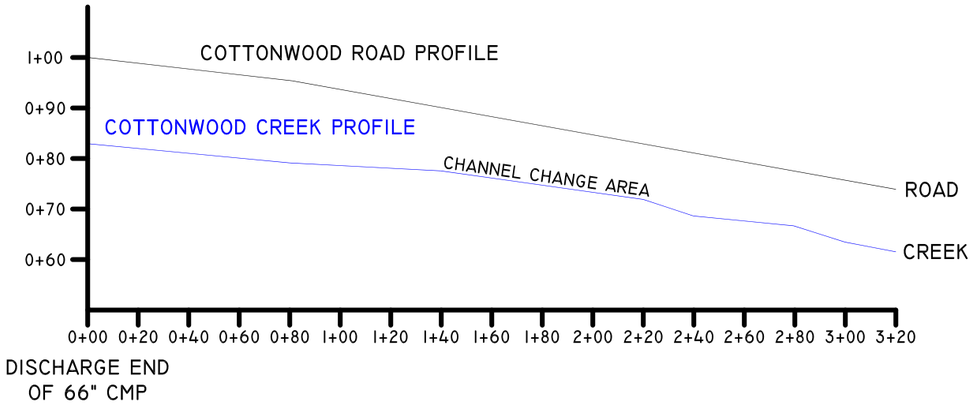
*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# EXISTING AND PHASE II RECLAMATION CROSS SECTIONS
## PLATE 5-14B

| SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|
| 1" = 40' | 9/24/2019 | A.B.E. | A.B.E. | X.X.X. | 5-14B |

FILE NAME: Plate 5-14B Phase II Rec Cross Sections

SSlaughter 4/15/2020 7:44 AM




## NOTES

| | |
|---|---|
| SIDE SLOPES | 2:1 BOTTOM |
| WIDTH | MINIMUM OF 5.0 FEET |
| SLOPE | NATURAL 7% |
| CHANNEL DEPTH | MINIMUM OF 4.0 FEET |
| DISCHARGE | MINIMUM OF 535 CFS |

## RIPRAP

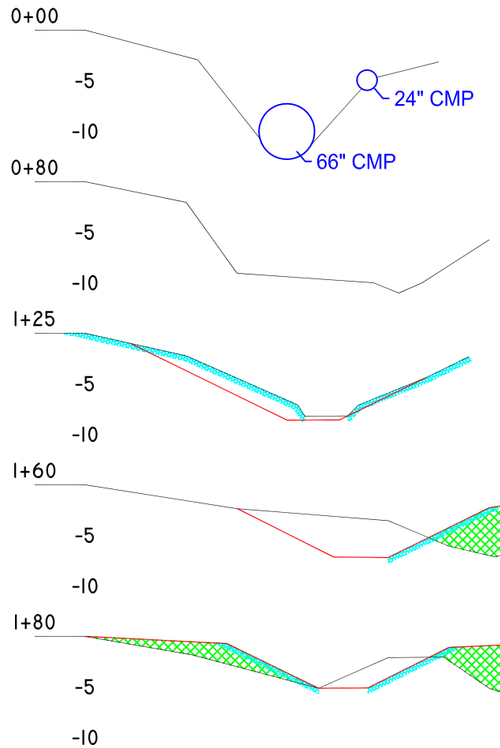
6" OF 2" ROAD BASE ON SLOPES ($D_{50}$) -1.4 FEET. (MEDIUM DIAMETER) FOR METHODOLOGY SEE APPENDIX 7-25 AND 7-27 (4-5) OF THE TRAIL MOUNTAIN TRACT 1 MPR.

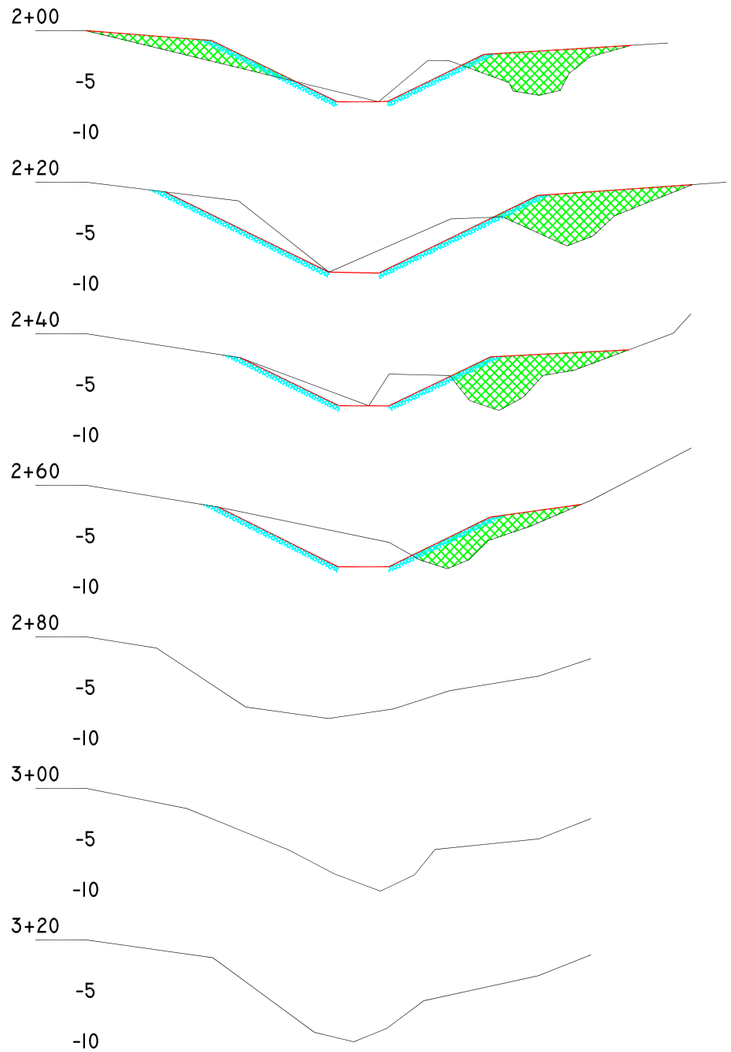
THE BANKS WILL BE CONTOURED TO APPROXIMATELY 2:1 SLOPE AND WILL BE COMPACTED WITH A BACKHOE PRIOR TO PLACING RIPRAP. RIPRAP WILL BE DISTRIBUTED ALONG THE CHANNEL BANKS. RIPRAP WILL BE PLACED 4.5 FEET HIGH ALONG THE BANKS.

## LEGEND

FILL

RIPRAP




SSlaughter: 4/15/2020 7:47 AM

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

**FOSSIL ROCK MINE**

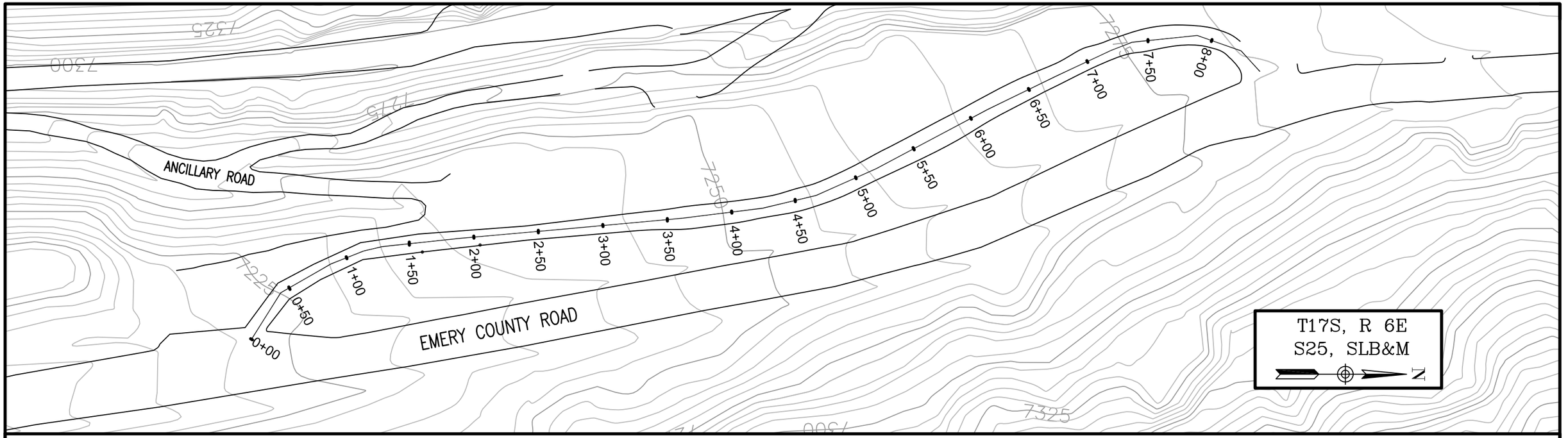
**Cottonwood Creek Channel Change Cross Sections**

| | | | | |
|---|---|---|---|---|
| SCALE: 1" = 15' | DATE: 4/13/2020 | DRAWN BY: A.B.E. | ENGINEER: X.X.X. | CHECKED BY: X.X.X. |
| FILE NAME: Plate 5-15 Cottonwood Creek Cross Sections | | | | SHTS: 11X17 SHEET |

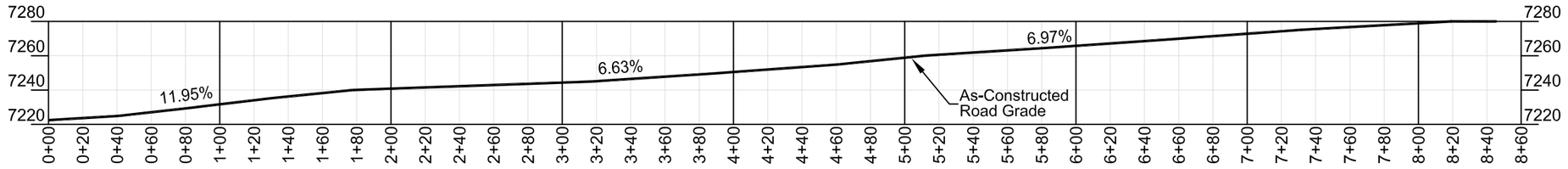
REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

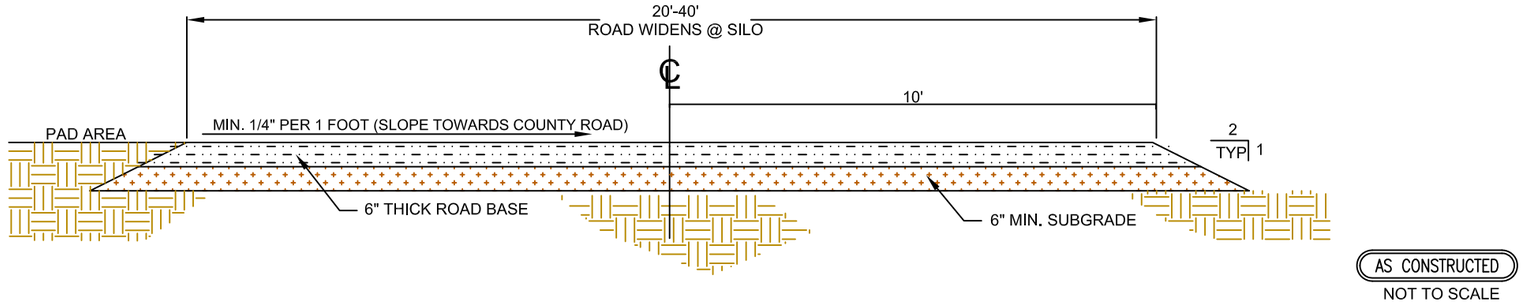
SHEET NO. 5-15




## HAUL ROAD PROFILE - EXISTING




## TYPICAL SECTION




AS CONSTRUCTED

NOT TO SCALE

SSlaughter: 4/15/2020 7:48 AM

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

**FOSSIL ROCK MINE**

**PRIMARY ROAD PLAN AND PROFILE**

| SCALE: 1" = 75' | DATE: 9/25/2019 | DRAWN BY: A.B.E. | ENGINEER: X.X.X. | CHECKED BY: X.X.X. |
|---|---|---|---|---|
| FILE NAME: Plate 5-16 Primary Road Plan and Profile | | | | SHTS: 11X17 SHEET |

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

SHEET NO.

5-16

UNITED STATE FOREST SERVICE BOUNDARY MARKER
BOUNDARY MARKER
UNITED STATES FOREST SERVICE BOUNDARY MARKER
COTTONWOOD CREEK
CULVERT INLET
BERM
ASPHALT PARKING LOT
CONCRETE BARRIER
GATE
BATHOUSE
BATHOUSE
BATHOUSE
OFFICE
OFFICE
SHOP
SUB-STATION
STORAGE SHED
SWITCH HOUSE
TOPSOIL
FUEL PUMPS
LOADING DOCK
GATE
FAN
TANK FARM
PUMP HOUSE
WATER TANK
PUMP HOUSE
ROCK DUST SILO
SEALED MAY 2001
STORAGE
STORAGE
TRASH BUNKER NON-COAL
SALT STORAGE SHED
ANCILLARY ROAD
DIESEL ROADWAY
UNDISTURBED
STORAGE
STORAGE
COAL STORAGE
BELT
WASTE ROCK STORAGE
CRUSHER & STRUCTURE
SUB-STATION
TRUCK LOADOUT 600 TON SILO
EMERY COUNTY ROAD
CURB/GUTTER/FENCE
OLD WOOD BLDG.
STORAGE
ANCILLARY ROAD
STORAGE
GATE
UNDISTURBED
SEALED MAY 2001
PERMIT BOUNDARY 17.97 AC
DISTURBED AREA BOUNDARY 10.39 AC
COTTONWOOD CREEK
UNDISTURBED
UNITED STATES FOREST SERVICE BOUNDARY MARKER
UNITED STATE FOREST SERVICE BOUNDARY MARKER
N

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- UTILITY POLE

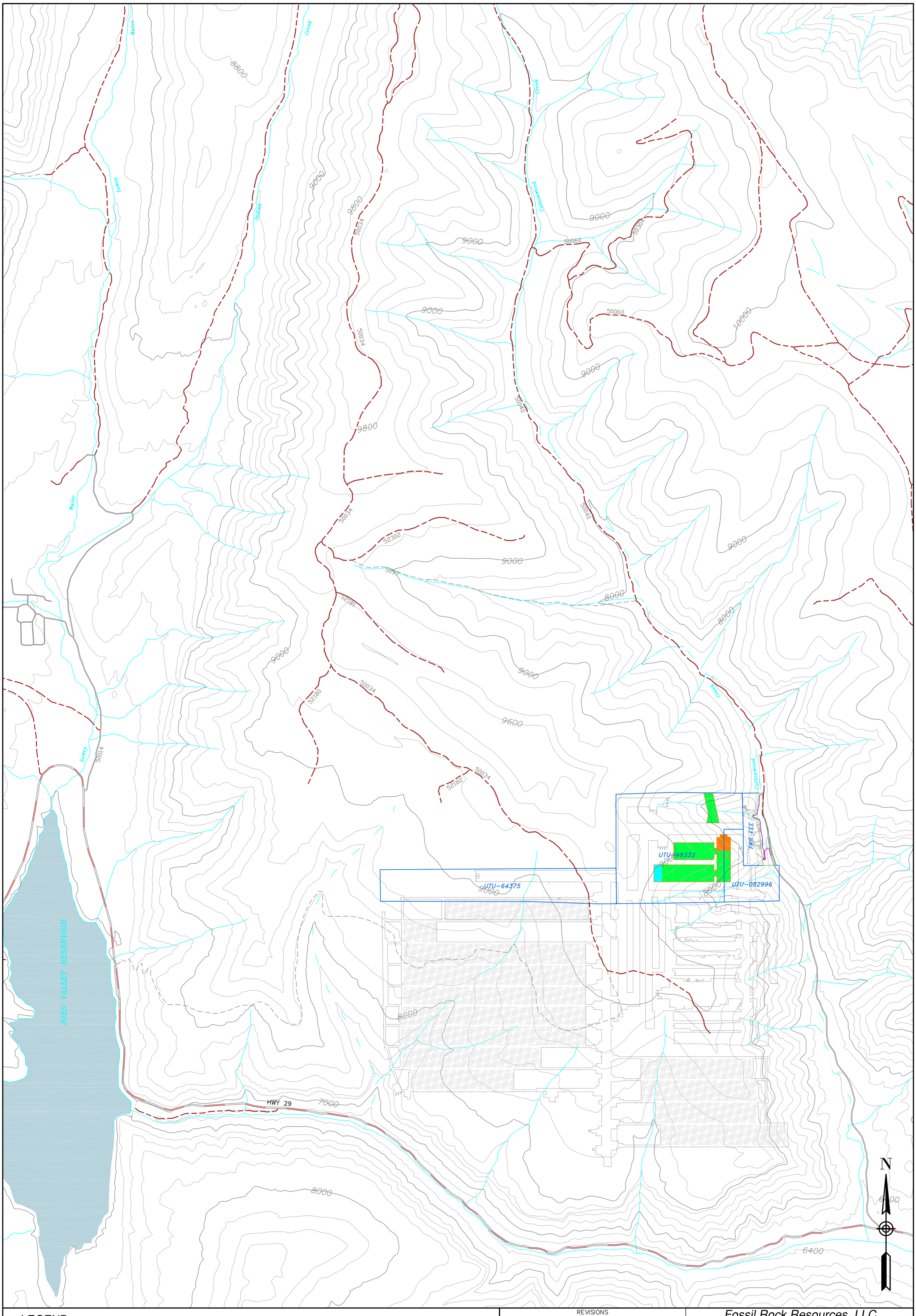
SStoughton 4/15/2020 6:48 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# SURFACE FACILITIES EXISTING
# PLATE 5-2

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 100' | 9/18/2019 | A.B.E. | A.B.E. | X.X.X. | 5-2 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 5-2 SURFACE FACILITIES | | | | |




## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED

## MINING AREA

- TRAIL MOUNTAIN MINE (MINING COMPLETED)
- 2021 MINING
- 2022 MINING
- 2023 MINING

SSlaughter 4/15/2020 6:49 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# 5 YEAR MINE PLAN
# PLATE 5-3

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,200' | 12/10/2019 | A.B.E. | A.B.E. | X.X.X. | 5-3 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 5-3 Mine Plan | | | | |

Lost Basin
Wasatch Plateau
Black Canyon
Mid Mtn
Dry Basin
Trail Mtn
Reeder Canyon
Reynold Point
Trail Mtn
Little Canyon
Joes Valley Reservoir
Straight Canyon
Lower Joes Valley
Winks Canyon
Mill Canyon
Dairy Canyon
Indian Lodge Canyon
Trail Canyon
Roans Canyon
Flaglake Canyon
T17S R6E
T17S R7E
North Fork Meetinghouse Canyon
Meetinghouse Canyon
East Mtn
Elk Canyon
Grimes Wash
Snow Lake
UTU-49332
UTU-64375
UTU-082596
FOSSIL ROCK WASTE ROCK SITE

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY

PORTIONS OF THE FOLLOWING USGS 7.5 MINUTE QUAD MAP;
*HIAWATHA, JOES VALLEY RESERVOIR, MAHOGONAY POINT, RED POINT, RILDA CANYON, OR SOUTH TENT MOUNTAIN*

## SURFACE OWNERSHIP

- FOSSIL ROCK
- PRIVATE PROPERTY
- UNITED STATES FOREST SERVICE
- BUREAU OF LAND MANAGEMENT
- STATE OF UTAH

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

SURFACE OWNERSHIP
PLATE 5-4

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,800' | 4/13/2020 | A.B.E. | X.X.X. | X.X.X. | 5-4 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 5-4 Surface Ownership | | | | |

S:\Gauthier, 4/15/2020, 7:33 AM

T. 16 S.
T. 17 S.
R. 6 E.
R. 7 E.
Lowry
Indian
Creek
Cottonwood
Cottonwood Creek
FRR FEE
UTU-049332
UTU-64375
UTU-082996
HWY 29
9000
9800
10000
8000
7000
50034
50060
50040
52302
52180
52182
N

NOTE:
ALL UNIDENTIFIED COAL OUTSIDE OF LEASE BOUNDARY FEDERAL COAL ADMINISTRATED BY THE BUREAU OF LAND MANAGEMENT

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED

## COAL OWNERSHIP

- FOSSIL ROCK FEE
- PACIFICORP FEE
- FOSSIL ROCK LEASED FEDERAL
- UTAH STATE LANDS (SITLA) COAL

SSlaughter: 4/15/2020 7:31 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

COAL OWNERSHIP
PLATE 5-5

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,200' | 9/18/2019 | A.B.E. | A.B.E. | X.X.X. | 5-5 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 5-5 Coal Ownership | | | | |

T. 16 S.
T. 17 S.

Lowry

Indian

Cottonwood

Creek

UTU-049332

UTU-64375

UTU-082996

FFR - A.E.

## LEGEND

① 10TH RIGHT LONGWALL (148 SHIELDS & FACE CONVEYOR), FEBRUARY 26, 2001 BLM APPROVED THE ABANDONMENT OF LONGWALL SHIELD DUE TO SAFETY CONCERNS.

② 3RD RIGHT LONGWALL (3 SHIELDS), DECEMBER 11, 2000 BLM APPROVED THE ABONDONMENT OF LONGWALL SHIELD DUE TO SAFETY CONCERNS.

TEMPORARY CESSION, ABONDONED MATERIALS

6" STEEL, WATER PIPELINE

12" PVC, WATER PIPELINE

SSlaughter: 4/15/2020 7:33 AM

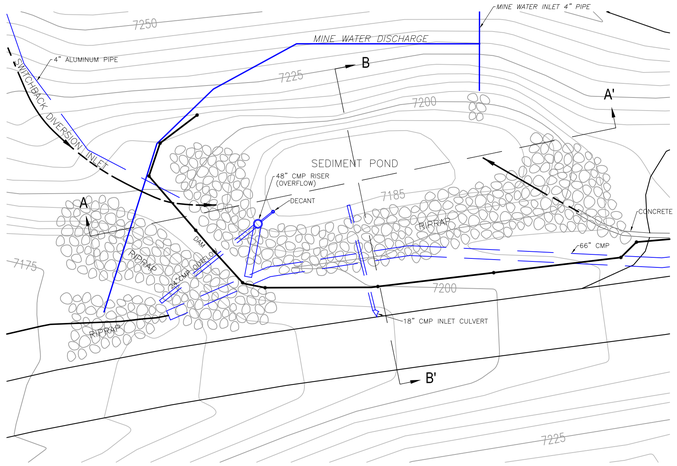
# Fossil Rock Resources, LLC
# Fossil Rock Mine
597 South SR 24 - Salina, UT 84654

## ABONDONED EQUIP. & PIPELINES
## PLATE 5-7

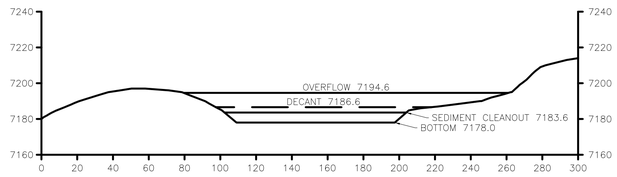
| | | |
|---|---|---|
| SCALE: 1" = 2,500' | DATE: 09/23/2019 | DRAWN BY: A.B.E |
| ENGINEER: X.X.X. | CHECKED BY: X.X.X. | SHT: 11X17 SHEET |
| FILE NAME: Plate 5-7 – Abondoned Equip And Pipe | | |

SHEET NO.

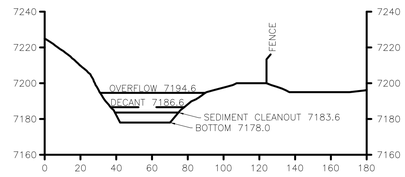
5-7



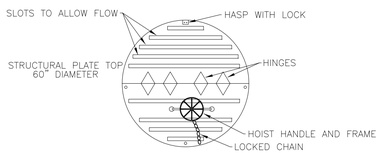

PLAN VIEW
CAPACITY 2.24 ACRE FEET



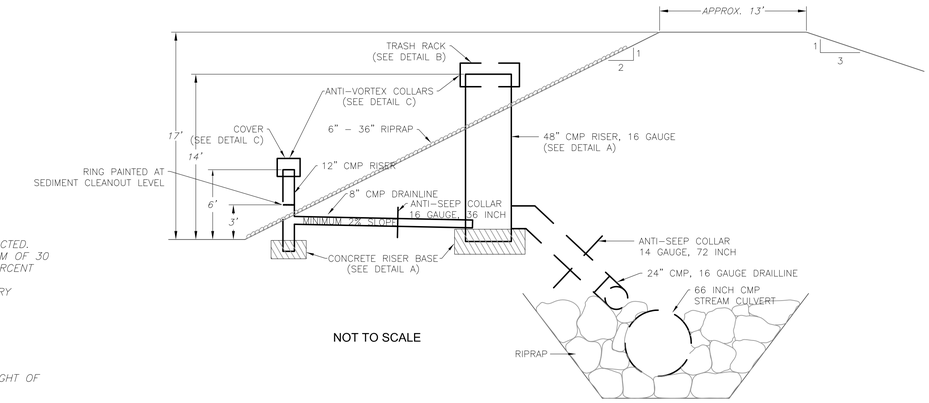

SECTION A-A'




SECTION B-B'



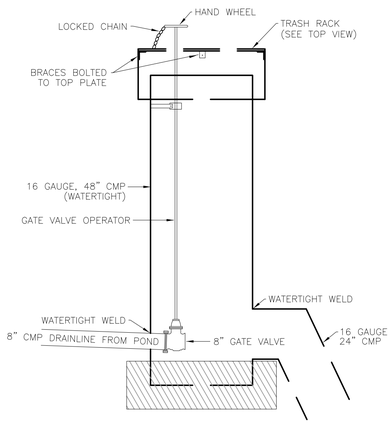

TOP VIEW



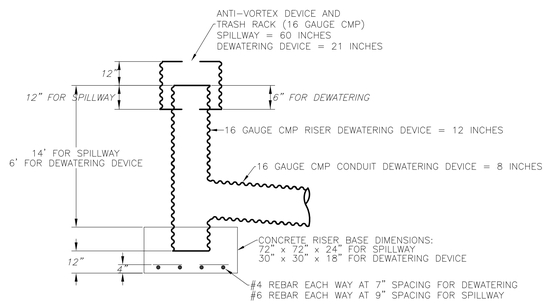

NOT TO SCALE

NOTES:

1. EMBANKMENT FILL MATERIAL SHALL BE LAID IN 6 TO 8 INCH CONTINUOUS LAYERS AND MACHINE COMPACTED.
2. EMBANKMENT FILL MATERIAL SHALL HAVE A WELL DISTRIBUTED PARTICLE SIZE GRADATION WITH A MINIMUM OF 30 PERCENT PASSING THE 66 MESH SIEVE AND A MINIMUM OF 12 PERCENT AND MAXIMUM SIZE OF 50 PERCENT PASSING THE NO. 200 MESH SIEVE.
3. EMBANKMENT FILL MATERIAL SHALL BE COMPACTED TO A MINIMUM OF 95 PERCENT OF THE MAXIMUM DRY DENSITY (STANDARD PROCTOR).
4. FILL MATERIAL AROUND CONDUITS SHALL BE HAND COMPACTED.
5. RIPRAP SHALL BE PLACED AT POINT OF INFLOW AND OUTFLOW.
6. EMBANKMENT AND DISTURBED AREAS SHALL BE REVEGETATED FOLLOWING CONSTRUCTION.
7. REFERENCE ELEVATION IS BOTTOM OF POND (7187.5 FT. MSL).
8. WATERTIGHT CONNECTIONS SHALL BE USED.
9. RIPRAP SHALL BE PLACED 5 FEET ON BOTH SIDES OF SPILLWAY AND DEWATERING DEVICE UP FULL HEIGHT OF EMBANKMENT.
10. THE FOUNDATION SHALL BE CLEARED OF DEBRIS AND SCARIFIED PRIOR TO EMBANKMENT CONSTRUCTION.
11. THE INSIDE OF THE POND SHALL BE LINED WITH 18 INCHES OF EMBANKMENT MATERIAL MIXED WITH 10 PERCENT BENTONITE.
12. EMBANKMENT SHOULD BE COMPACTED WITHIN ±2 PERCENT OF OPTIMAL MOISTURE CONTENT AS DETERMINED BY THE STANDARD PROCTOR TEST.

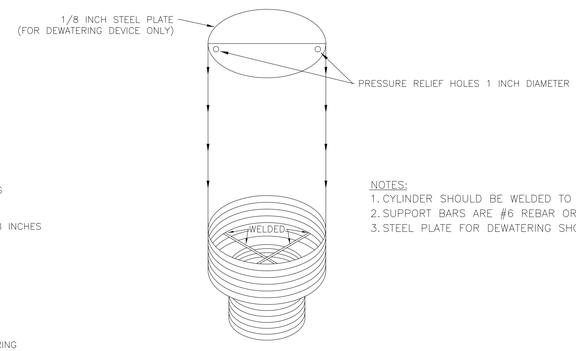



CROSS SECTION
NOT TO SCALE




NOT TO SCALE

DESIGN DETAIL OF SPILLWAY AND DEWATERING DEVICE
DETAIL A




NOTES:
1. CYLINDER SHOULD BE WELDED TO THE TOP OF THE RISER.
2. SUPPORT BARS ARE #6 REBAR OR EQUIVALENT.
3. STEEL PLATE FOR DEWATERING SHOULD BE WELDED TO CYLINDER.

NOT TO SCALE

CLOSE UP ANTI-VORTEX DEVICE AND TRASH RACK
DETAIL B

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

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*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

SEDIMENT POND DETAILS AS CONSTRUCTED
PLATE 5-8

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,800' | 9/3/2019 | A.B.E. | X.X.X. | X.X.X. | 5-8 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 5-8 - Sediment Pond Details as Constructed | | | | |

5/5/2020 7:41 AM

UNITED STATE FOREST SERVICE BOUNDARY MARKER
COTTONWOOD CREEK
UNITED STATES FOREST SERVICE BOUNDARY MARKER
BERM
66" CULVERT
16" CMP
24" CMP INLET
SEPTIC TANK
12"CMP
TM-1B
MH
DROP INLETS
16" CMP
4" DRAIN
SEPTIC TANKS
MH
8" SEWER LINE
66" CMP
TOPSOIL PILE
48" CULVERT
24" CMP RISER
36" CMP INLET
8" DISCHARGE LINE
12"CMP
12"CMP
SEWER COLLECTION BUILDING
8" WATER LINE
CURB/GUTTER/FENCE
6" PIPE
EMERY COUNTY ROAD
24" CMP
DROP DRAIN
66" CULVERT
SEDIMENT POND
48" CMP RISER
24" CMP
UPDES 001 & 002
SW-2
PERMIT BOUNDARY 17.97 AC
DISTURBED AREA BOUNDARY 10.39 AC
COTTONWOOD CREEK
24" CMP
4" ALUM. PIPE
48" CMP
UNITED STATES FOREST SERVICE BOUNDARY MARKER
UNITED STATE FOREST SERVICE BOUNDARY MARKER
N

## LEGEND

- PERMIT BOUNDARY
- DISTURBED AREA BOUNDARY
- WATER WELL
- SURFACE DRAINAGE
- TM-1B (ABANDONED)

SSlaughter: 4/15/2020 7:36 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: 24X36 SHEET
PROJECT NUMBER: ####

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*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# DRAINAGE CONTROLS
# PLATE 5-9

| SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|
| 1" = 100' | 9/23/2019 | A.B.E. | A.B.E. | X.X.X. | 5-9 |

FILE NAME: Plate 5-3 DRAINAGE CONTROLS

## CORRELATION OF MAP UNITS

| | | |
|---|---|---|
| Qal | | QUATERNARY |
| If | Eocene and Paleocene | TERTIARY |
| TKn | Paleocene and Upper Cretaceous | |
| Unconformity | | |
| Kpr | Mesaverde Group / Upper Cretaceous | CRETACEOUS |
| Kc | | |
| Kb | | |
| Ksp | | |
| Kmm | | |

## DESCRIPTION OF MAP UNITS

**TKn** — NORTH HORN FORMATION (PALEOCENE AND UPPER CRETACEOUS)
Shale, variegated with shades of gray, purple red, and brown; limestone, light to medium gray; sandstone gray and grayish orange; conglomerate. Thickness about 400 m

**Kpr** — PRICE RIVER FORMATION (UPPER CRETACEOUS)
Sandstone, gray to light gray, coarse grained to conglomeratic, some interbedded shale. Thickness about 90 m

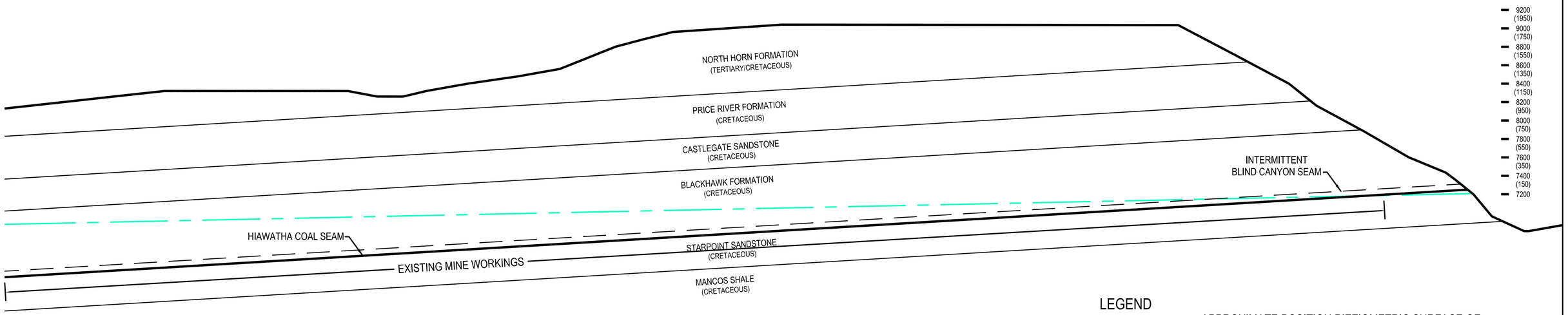
**Kc** — CASTLEGATE SANDTSONE (UPPER CRETACEOUS)
Sandstone weathers grayish orange, coarse grained, massive, cliff forming; some oxidation on surface. Thickness 75 m

**Kb** — BLACKHAWK FORMATION (UPPER CRETACEOUS)
Sandstone, grayish orange to medium gray, medium to fine grained, most in lentic-ular bodies with erosional base; shale silty gray; coal. Locally intertongues with Star Point Sandstone (Ksp). Thickness 225-245 m

**Ksp** — STAR POINT SANDSTONE (UPPER CRETACEOUS)
Sandstone, siltstone, and shale, gray to grayish orange, cliff forming. Thickness 75-90 m

**Kmm** — MANCOS SHALE (UPPER CRETACEOUS)
Masuk Member-Shale, medium to dark gray, weathers yellowish gray, sandy in part. Thickness about 260 m

A (WEST) — A' (EAST)




## LEGEND

APPROXIMATE POSITION PIEZIOMETRIC SURFACE OF BLACKHAWK-STAR POINT AQUIFER

REFER TO PLATE 6-2 FOR CROSS SECTION LOCATION

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

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CROSS SECTION A-A
PLATE 6-1

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 500' | 4/13/2020 | A.B.E. | X.X.X. | X.X.X. | 6-1 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 6-1 Cross-Section A-A | | | | |

PSLayout - 4/6/2020 7:49 AM

## LEGEND

- LEASE BOUNDARY
- ROAD PAVED
- FAULT (DASHED WHERE INFERRED)
- * GAS WELL
- • DRILL HOLE
- EM-12C EAST MTN. DRILL HOLE NO.12 (C=CORED)
- TM-10 TRAIL MTN. DRILL HOLE NO.10

| | |
|---|---|
| Tf | FLAGSTAFF FORMATION |
| TKnh | NORTH HORN FORMATION |
| Kpr | PRICE RIVER FORMATION |
| Kcg | CASTLE GATE SANDSTONE |
| Kbh | BLACK HAWK FORMATION |
| Ksp | STARPOINT SANDSTONE |
| Km | MANCOS SHALE |

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

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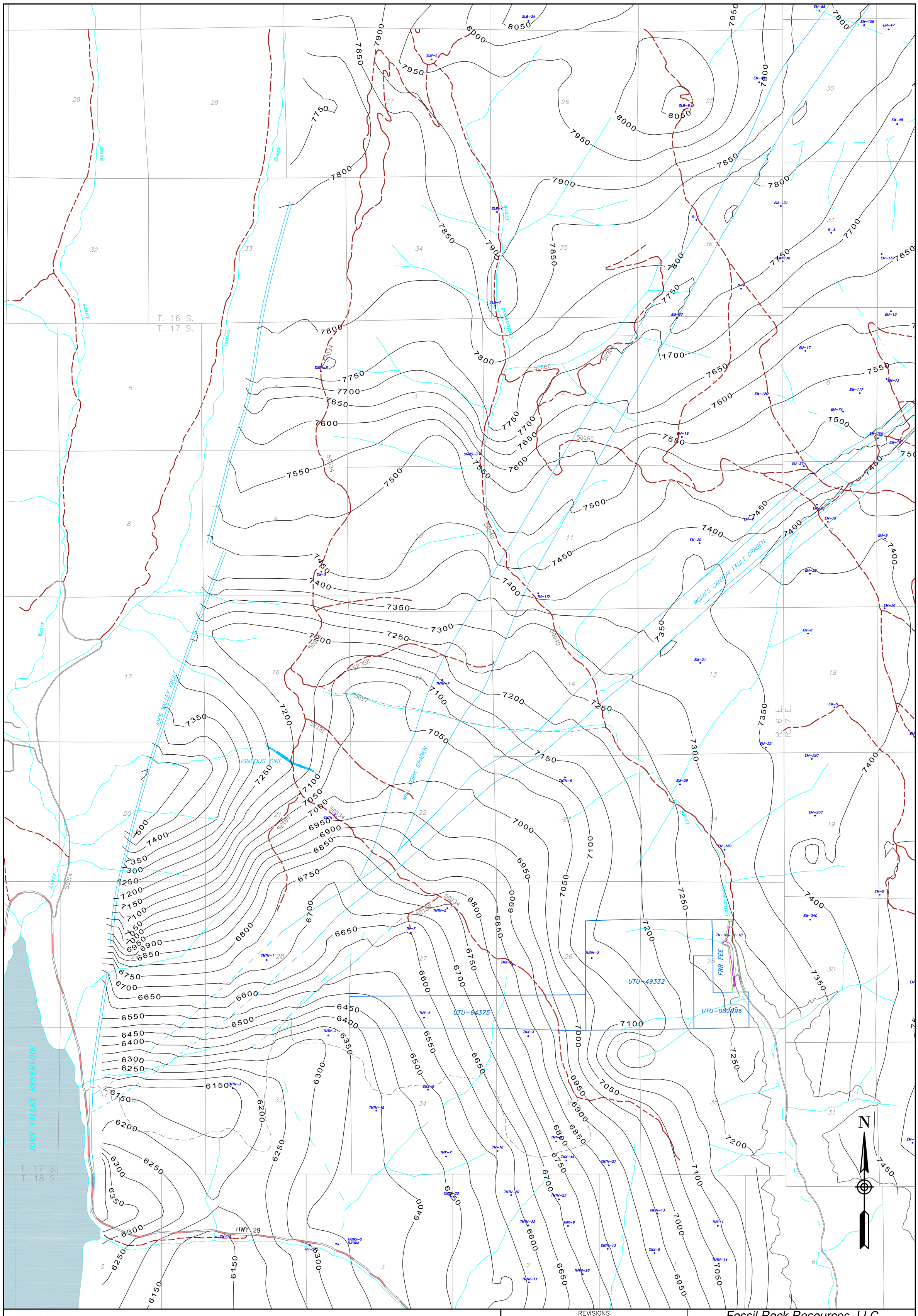
*597 South SR 24 - Salina, UT 84654*

GEOLOGY BASE MAP
PLATE 6-2

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 9/25/2019 | A.B.E. | A.B.E. | X.X.X. | 6-2 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 6-2 Geology Base Map | | | | |

SSlaughter 4/15/2020 7:51 AM




## LEGEND

- LEASE BOUNDARY
- ROAD PAVED
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- 6100 COAL ISOPACH
- DRILL HOLE
- EM-12C EAST MTN. DRILL HOLE NO.12 (C=CORED)
- TM-10 TRAIL MTN. DRILL HOLE NO.10

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

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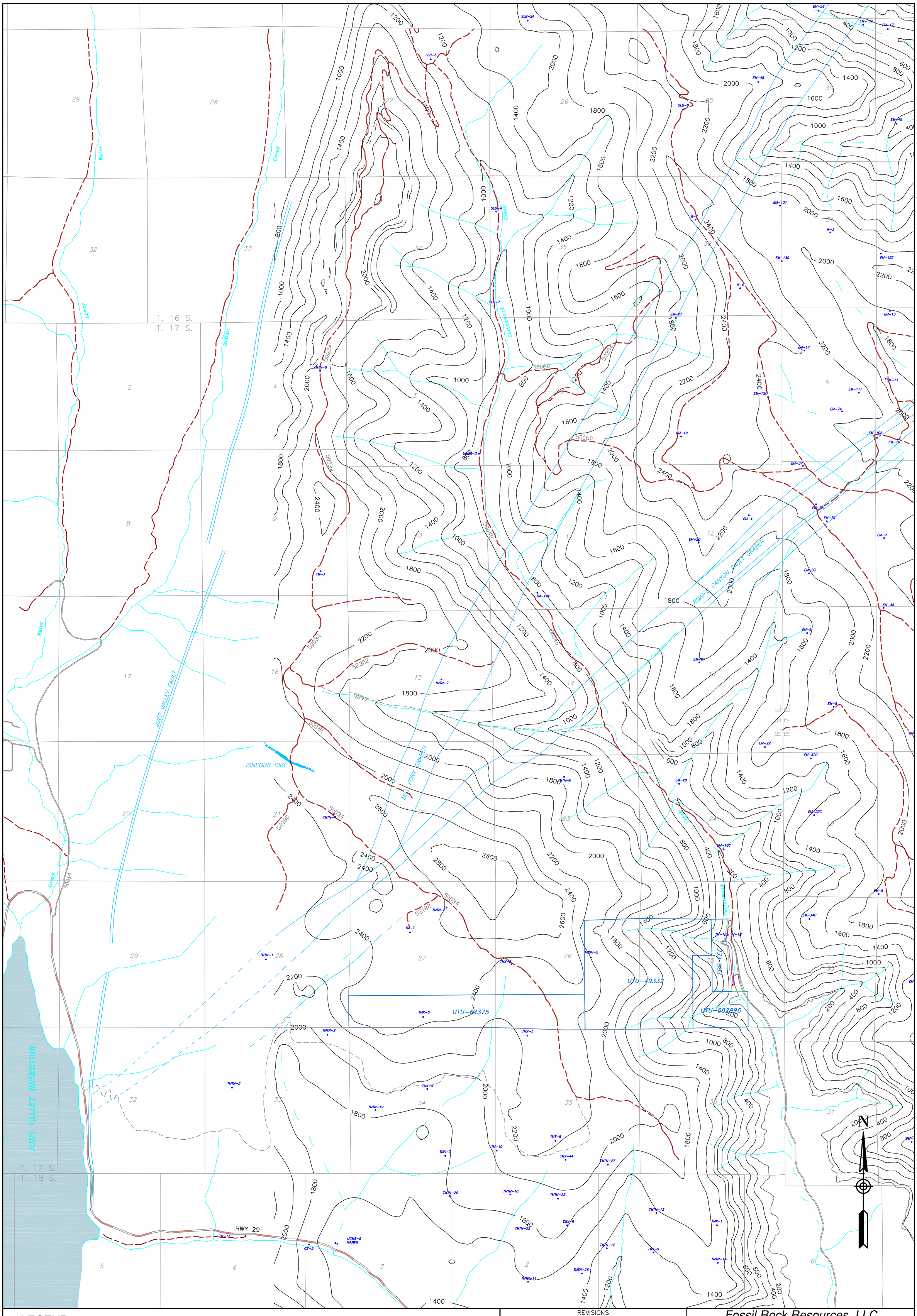
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

SEAM STRUCTURAL CONTOUR MAP
PLATE 6-3

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 9/25/2019 | A.B.E. | A.B.E. | X.X.X. | 6-3 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 6-3 Seam Structural Contour Map | | | | |

SSlaughter 4/15/2020 7:53 AM




## LEGEND

- LEASE BOUNDARY
- ROAD PAVED
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- 2000 — COAL ISOPACH
- DRILL HOLE
- EM-12C — EAST MTN. DRILL HOLE NO.12 (C=CORED)
- TM-10 — TRAIL MTN. DRILL HOLE NO.10

REVISIONS

| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
|---|---|---|---|---|
| 1 | 04/13/2020 | VSM | JKS | |

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: 24X36 SHEET
PROJECT NUMBER: ####

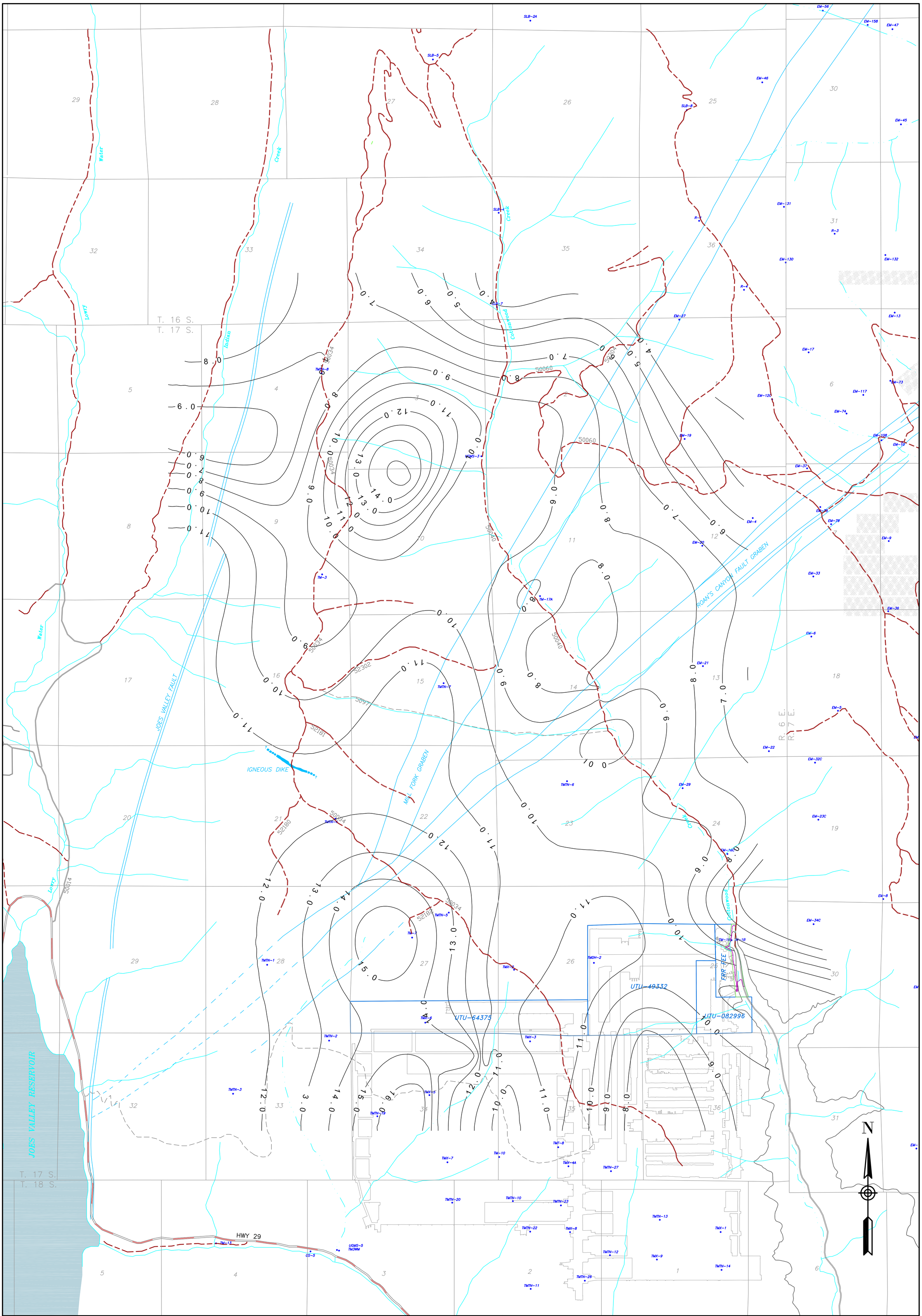
*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# HIAWATHA SEAM OVERBURDEN ISOPACH MAP
## PLATE 6-4

| SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|
| 1" = 1,500' | 9/25/2019 | A.B.E. | A.B.E. | X.X.X. | 6-4 |

FILE NAME: Plate 6-4 Seam Overburden Isopach

SSlaughter: 4/15/2020 7:54 AM




## LEGEND

- LEASE BOUNDARY
- ROAD PAVED
- FAULT (DASHED WHERE INFERRED)
- OUTCROP
- 10.0 COAL ISOPACH
- DRILL HOLE
- EM-12C EAST MTN. DRILL HOLE NO.12 (C=CORED)
- TM-10 TRAIL MTN. DRILL HOLE NO.10

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

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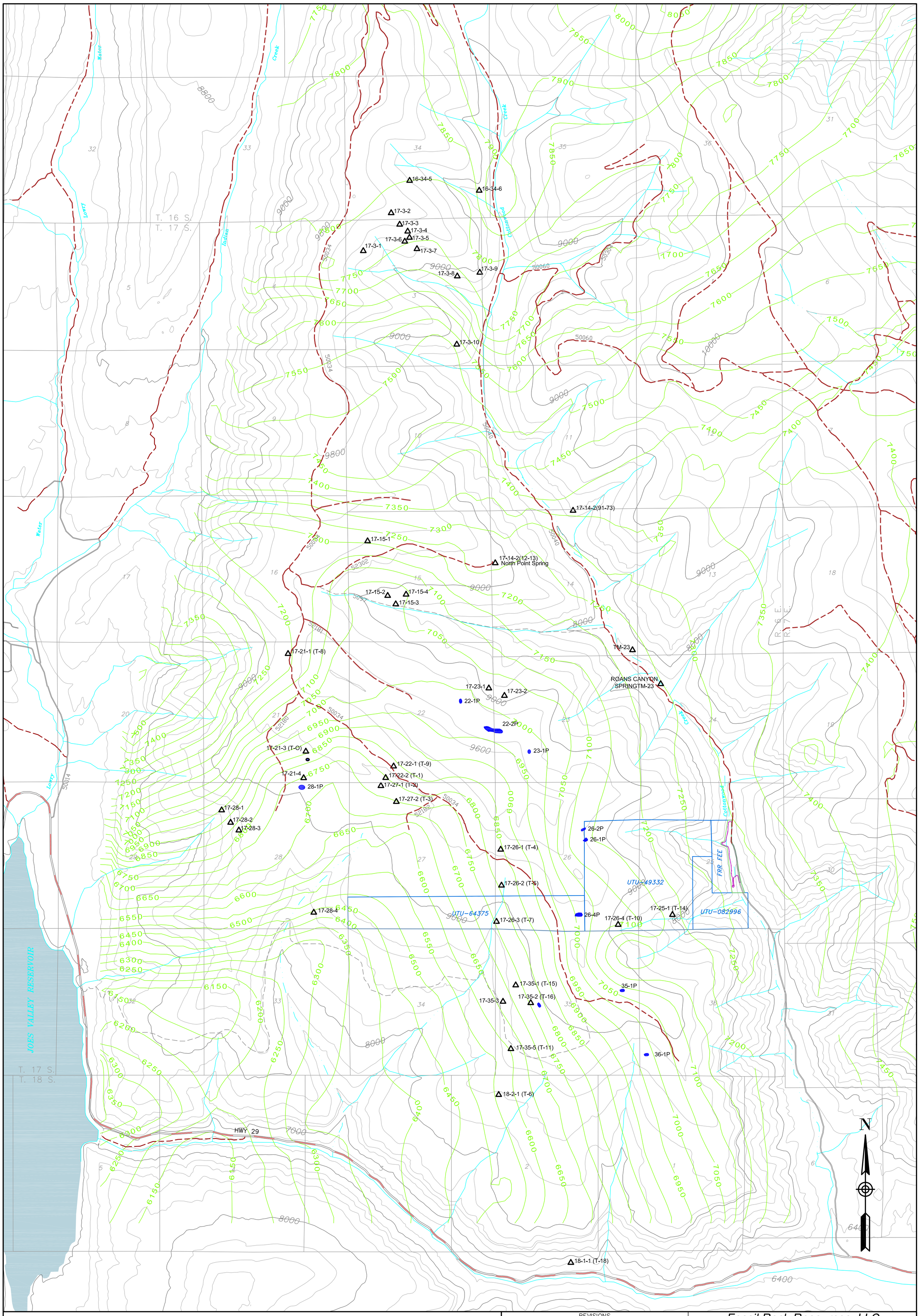
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# HIAWATHA SEAM THICKNESS ISOPACH MAP
# PLATE 6-5

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 9/25/2019 | A.B.E. | A.B.E. | X.X.X. | 6-5 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 6-5 Coal Seam Isopach | | | | |

SSlaughter: 4/15/2020 7:55 AM




## LEGEND

- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED
- 6400 — STRUCTURAL CONTOUR LINES (Base of Hiawatha, Top of Starpoint Sandstone)
- △ 17-24-1 — SPRING
- 26-4P — POND

SSlaughter: 4/15/2020 7:56 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

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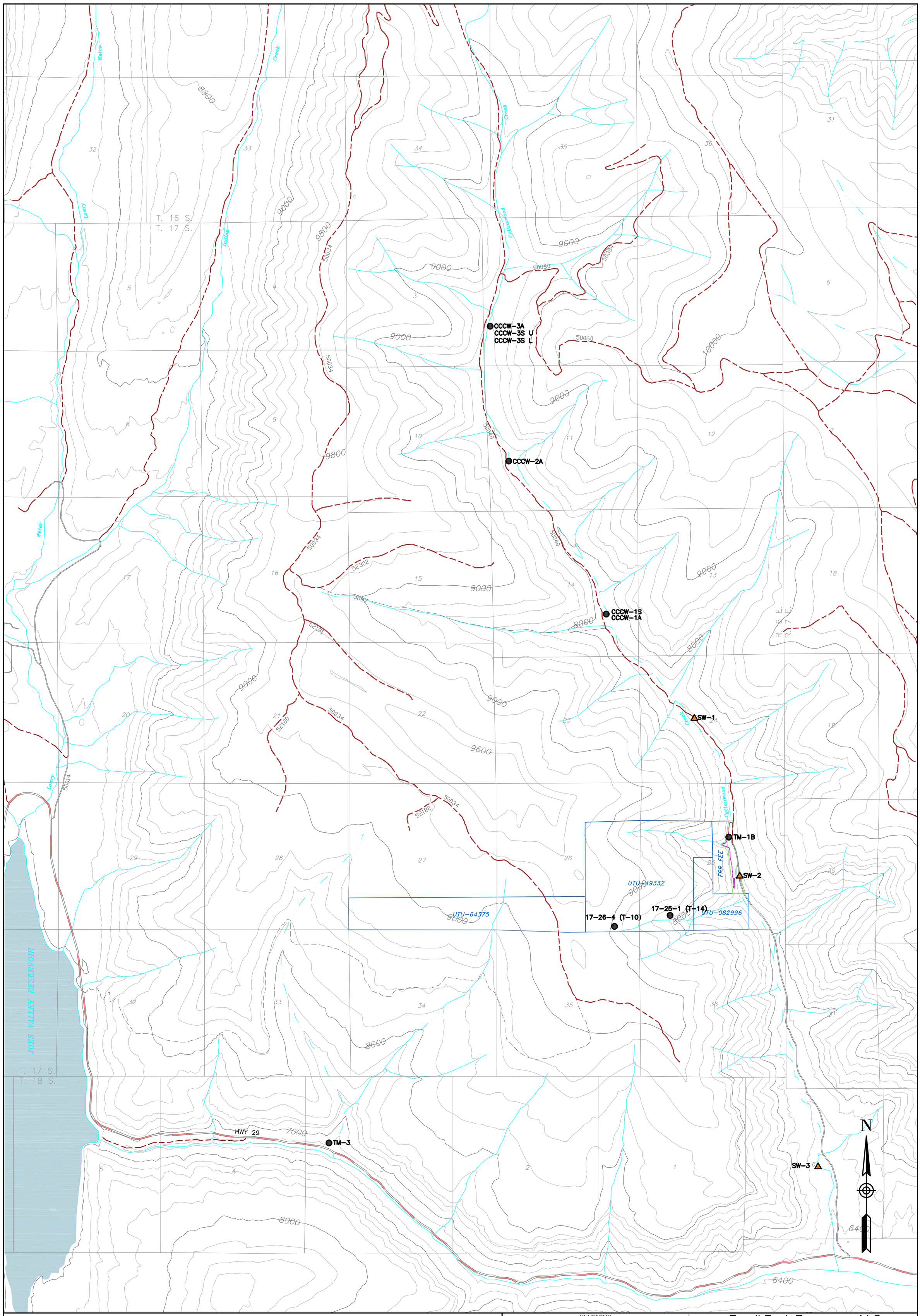
*597 South SR 24 - Salina, UT 84654*

# SPRING MAP
# PLATE 7-1

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 9/25/2019 | A.B.E. | A.B.E. | X.X.X. | 7-1 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 7-1 Spring Map | | | | |




## LEGEND

- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED
- SURFACE WATER
- GROUND WATER

SSlaughter: 4/15/2020 7:57 AM

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

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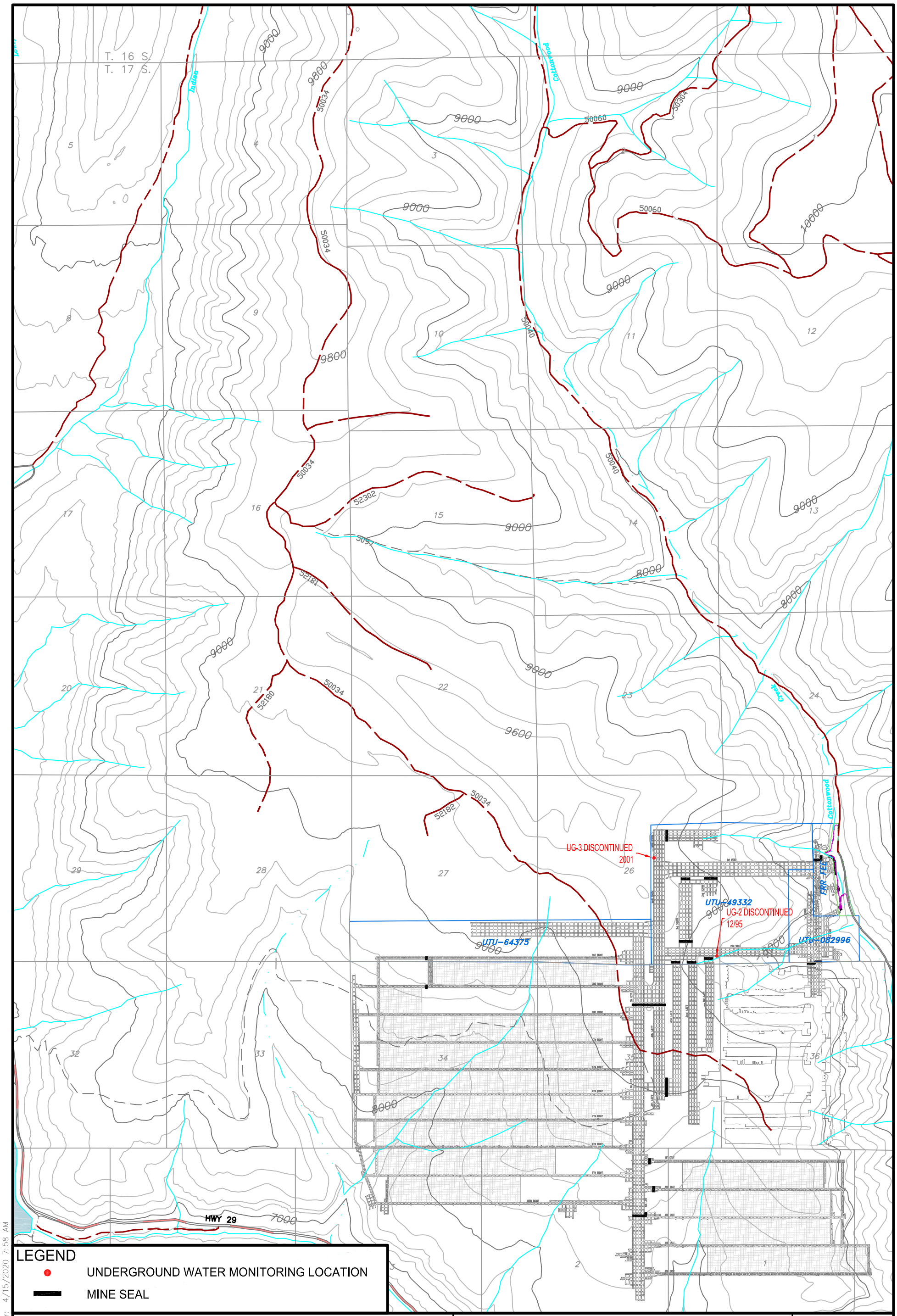
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# WATER MONITORING LOCATIONS
# PLATE 7-2

| PEN TBL: | SCALE: | DATE: | DRAWN BY: | ENGINEER: | CHECKED BY: | SHEET NO. |
|---|---|---|---|---|---|---|
| _1Stndrd-SUFENP1.ctb | 1" = 1,500' | 1/14/2020 | A.B.E. | A.B.E. | X.X.X. | 7-2 |
| SHT SET: 24X36 SHEET | PROJECT NUMBER: #### | FILE NAME: Plate 7-2 Water Monitoring Locations | | | | |




SSlaughter: 4/15/2020 7:58 AM

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*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

# FOSSIL ROCK MINE

## UNDERGROUND WATER MONITORING LOCATIONS

| | | |
|---|---|---|
| SCALE: 1" = 2,500' | DATE: 09/25/2019 | DRAWN BY: A.B.E. |
| ENGINEER: X.X.X. | CHECKED BY: X.X.X. | PROJ: #### |
| FILE NAME: 7–3 Underground Water Monitoring Locations | | |

SHEET NO.

7–3

93-1677
93-723
93-1591
93-1592
93-721
93-720
93-719
93-1592
93-706
93-717
93-718
93-706
93-1542
93-715
93-706
93-385
93-1626
93-1418
93-716
93-1625
93-385
93-1593
93-1623
93-1419
93-1419 (Pond)
93-2118
93-1616
93-1622
93-1617
93-1621
93-1620
93-708
93-2146
93-2147
93-2148
93-2149
93-2150
93-2151
93-792
93-789
93-2927
93-1677
93-789
93-792
93-2116
93-702
93-704
93-229
93-705
93-1606
93-701
93-1627
93-796
93-812
93-1022
93-2152
93-2153
93-2154
93-2117
93-229
93-700
93-699
93-697
93-696
93-695
93-694 (Pond)
93-691
93-690
93-689
(E2402)
93-1598
93-3698 (E2137)
93-692 (Pond)
93-693
93-3374
93-685
93-687
93-683
93-684
93-679 (Pond)
93-2115 (Pond)
93-3401 (Pond)
93-627 (Pond)
93-630 (Pond)
93-1088
93-3712
93-800
93-813
93-803
93-3712
93-1087

T. 16 S.
T. 17 S.
T. 17 S.
T. 18 S.

JOES VALLEY RESERVOIR

HWY 29

UTU-64375
UTU-049332
UTU-082996
FRR FEE

R. 6 E.
R. 7 E.

## LEGEND

- LEASE BOUNDARY
- ROAD PAVED
- ROAD UNIMPROVED
- 93-810 SURFACE WATER RIGHT
- 93-709 WATER RIGHT

## NOTE

WATER RIGHT DATA FROM UTAH DIVISION OF WATER RIGHTS.

| REVISIONS | | | | |
|---|---|---|---|---|
| NO. | DATE | REQ. BY | DWG. BY | REMARKS |
| 1 | 04/13/2020 | VSM | JKS | |

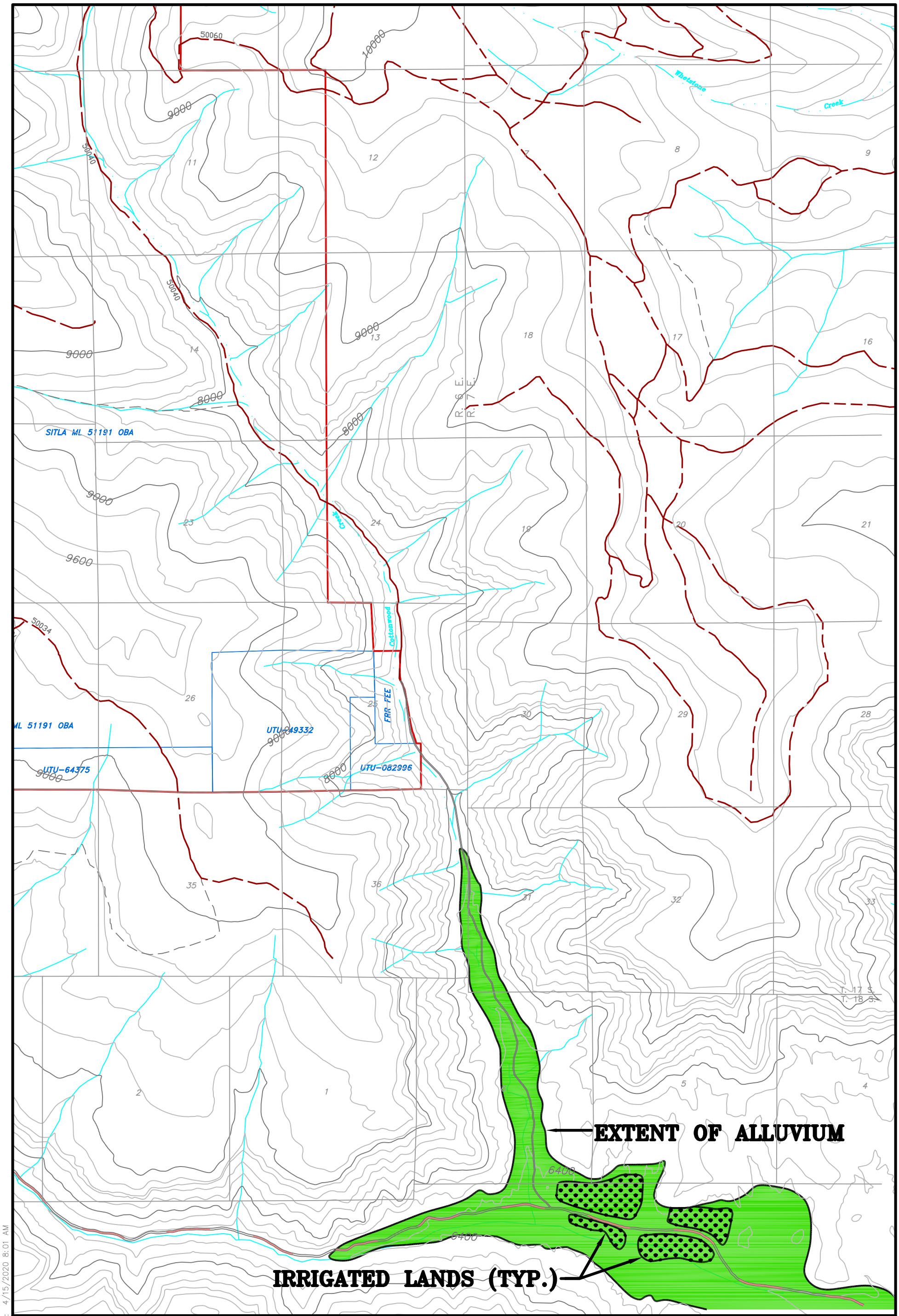
PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: 24X36 SHEET
PROJECT NUMBER: ####

SCALE: 1" = 1,500'
DATE: 9/26/2019
DRAWN BY: A.B.E.
ENGINEER: A.B.E.
CHECKED BY: X.X.X.
SHEET NO.: 7-4
FILE NAME: Plate 7-4 Surface Water Rights

SSlaughter: 4/15/2020 8:00 AM

# Fossil Rock Resources, LLC
## Fossil Rock Mine
*597 South SR 24 - Salina, UT 84654*

## SURFACE WATER RIGHTS
## PLATE 7-4




SSlaughter: 4/15/2020 8:01 AM

*Fossil Rock Resources, LLC*
*Fossil Rock Mine*
*597 South SR 24 - Salina, UT 84654*

| FOSSIL ROCK MINE | | | SHEET NO. |
|---|---|---|---|
| EXENT OF ALLUVIUM | | | 7–5 |
| SCALE: 1" = 2,500' | DATE: 9/25/19 | DRAWN BY: A.B.E. | |
| ENGINEER: X.X.X. | CHECKED BY: X.X.X. | PROJ: #### | |
| FILE NAME: 7–5 Extent of Alluvium | | | |