C/041/002 Incoming
#5259

Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

Sufco Mine

August 11, 2016

Permit Supervisor, Utah Coal 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: Revision to M&RP to Add Greens Hollow Lease Tract, Sufco Mine, Canyon Fuel Company, LLC, Permit Number C/041/0002

Dear Sirs:

Please find enclosed with this letter two volumes containing text, drawings and appendices with information related to the Greens Hollow Lease. As you are aware the process has been long in acquiring this lease, we are optimistic that sometime in the next few months the lease will be issued. Because we know the process for review and subsequent approval of the DOGM permit will take a while, we are requesting a preliminary review of the information we believe fulfills the regulations for permitting the lease.

We have submitted complete text for the chapters and any tables or figures that may have been changed. We have not included all tables and figures that did not require revisions. Revised plates have been submitted. The complete text has been submitted for ease of review. Since the pagination and in turn the Table of Contents will change with the inclusion and deletion of text the page numbers have not been revised or recorded in the Table of Contents.

If you have questions or need addition information please contact Vicky Miller at (435)286-4481.

CANYON FUEL COMPANY, SUFCO Mine

Vicky S Miller for

Kenneth E. May
General Manager

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: Sufco Mine **Permit Number:** C/041/0002

Title: Revision to M&RP to Add Greens Hollow Lease Tract

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.

X Yes ☐ No	1. Change in the size of the Permit Area? Acres: 6696.41 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?
X Yes ☐ 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?
X Yes ☐ No	7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☐ Yes X 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?
X Yes ☐ No	12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
X 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?
X Yes ☐ No	18. Does the application require or include water monitoring, sediment or drainage control measures?
X 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 X 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.

John D. Byars
Print Name

J D Byars Ops. mgr. 8-10-16
Sign Name, Position, Date

Subscribed and sworn to before me this 10 day of August, 2016

Jacquelyn Nebeker
Notary Public

My commission Expires: ____________, 20___ }
Attest: State of ____________ } ss:
County of ____________

JACQUELYN NEBEKER
Notary Public
State of Utah
My Commission Expires 03/24/2019
COMMISSION NUMBER 681827

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining
		RECEIVED AUG 1 1 2016 DIV. OF OIL, GAS & MINING

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

Permittee: Canyon Fuel Company, LLC
Mine: Sufco Mine **Permit Number:** C/041/0002
Title: Revisions to M&RP to Add Greens Hollow Lease Tract

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.

Add	Replace	Remove	DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Chapter 1
☒ Add	☐ Replace	☐ Remove	Appendix 1-1, add information to the back of the existing appendix
☐ Add	☒ Replace	☐ Remove	Chapter 2
☐ Add	☒ Replace	☐ Remove	Plate 2-3
☐ Add	☒ Replace	☐ Remove	Chapter 3
☐ Add	☒ Replace	☐ Remove	Plates 3-1, 3-2, and 3-3
☒ Add	☐ Replace	☐ Remove	Appendix 3-4, add information to the back of the existing appendix
☒ Add	☐ Replace	☐ Remove	Appendix 3-15
☐ Add	☒ Replace	☐ Remove	Chapter 4
☒ Add	☐ Replace	☐ Remove	Appendix 4-2, 4-5 and 4-6, add information to the back of the existing appendix
☐ Add	☒ Replace	☐ Remove	Plate 4-1B
☐ Add	☒ Replace	☐ Remove	Chapter 5
☐ Add	☒ Replace	☐ Remove	Plates 5-2C, 5-5, 5-6, 5-7, 5-8, 5-10A, 5-10C and 5-11
☐ Add	☒ Replace	☐ Remove	Chapter 6
☒ Add	☐ Replace	☐ Remove	Appendix 6-4, add information to the back of the existing appendix
☐ Add	☒ Replace	☐ Remove	Plate 6-1
☐ Add	☒ Replace	☐ Remove	Chapter 7
☐ Add	☒ Replace	☐ Remove	Plates 7-2 and 7-3
☒ Add	☐ Replace	☐ Remove	Appendix 7-1, add information to the back of the existing appendix
☒ Add	☐ Replace	☐ Remove	Appendix 7-27
☐ Add	☒ Replace	☐ Remove	Chapter 8
☐ Add	☒ Replace	☐ Remove	Chapter 9
☐ Add	☒ Replace	☐ Remove	Plate 9-1
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	
☐ Add	☐ Replace	☐ Remove	

Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	Received by Oil, Gas & Mining
August 10,2016	RECEIVED AUG 1 1 2016 DIV. OF OIL, GAS & MINING

THE ENTIRE TEXT FOR EACH CHAPTER IS INCLUDED IN THIS SUBMITTAL FOR EASE OF REVIEW.

ONCE APPROVED ONLY PAGES WITH CHANGES WILL BE SUBMITTED.

CHAPTER 1

GENERAL CONTENTS

TABLE OF CONTENTS (December 20, 1991)

Section **Page**

LIST OF APPENDICES

(Appendices appear in Volume 4)

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 Dugout Canyon Mine, Soldier Canyon Mine, SUFCO Mine, Skyline Mines, ~~and~~ Banning Loadout and other operations.

112 Identification of Interests

112.100 Business Entity

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

112.400 Coal Mining and Reclamation Operation Permit Applications Previous, Current or Pending

The following list describes ~~all~~ permits held by Canyon Fuel Company, LLC, ~~all~~ pending applications for permits, and ~~any~~ 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/041/002	State of Utah Department of Natural Resources Division of Oil, Gas and Mining	Approved
	Department of Interior U.S. Geological Survey and Office of Surface Mining	
	Department of Agriculture U.S. Forest Service Fishlake National Forest and Manti La Sal National Forest	
U.P.D.E.S. Permit UT-0022918	Environmental Protection Agency and Utah D.E.Q.	Approved
Disposal for Water Discharge	Utah Department of Health	Approved
Business License	Sevier County	Approved
Mine Health and Safety Permits 42-00089	Mine Safety and Health Administration - Utah	Approved
ID No. 1211-UT-09-00089-01	Mine Safety and Health Administration	Waste Rock Disposal Area Construction Plan
Radio Permits	Federal Communications Commission	Approved

Certificate of Insurance and Authorization to do Business in State	State Industrial Development Commission	Approved
Public Water Supply Permit #21020	State of Utah Department of Health Division of Environmental Health	Approved
Radiation Control	State of Utah Department of Environmental Quality, Division of Radiation Control	Approved
Special Use 4078-2	U.S. Forest Service Fishlake National Forest	Approved
Air Quality Approval Orders	State of Utah Utah Air Conservation Committee Department of Health Division of Environmental Health	Approved
Water Rights	State Engineer	Approved

A table of the Canyon Fuel Company, LLC mining permits and operations is located in General Chapter 1 ~~are:~~

SUFCO Mine	C/041/002
~~Skyline Mine~~	~~C/007/005~~
~~Soldier Canyon Mine~~	~~C/007/018~~
~~Banning Loadout~~	~~C/007/034~~
~~Dugout Canyon~~	~~C/007/039~~

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

Operations held by ~~subsidiary companies of Arch Coal, Inc.~~ 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 ~~prepared for the Dugout Canyon Mine, Soldier Canyon Mine, SUFCO Mine and Skyline Mines and Banning Loadout~~ operations.

112.500 Legal or Equitable Owner of the Surface and Mineral Properties

Owner of ~~all~~ the surface under Federal Coal Leases U-062453, SL-062583, U-0149084, U-047080, U-063214, U-28297, UTU-76195, UTU-84102 and State of Utah Coal Lease ML 49443-OBA is:

United States of America
Department of Agriculture
U.S. Forest Service
Fishlake National Forest
115 East 900 North
Richfield, Utah 84701

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
225 North 5th Street, 9th Floor
Grand Junction, CO 81501
Telephone: (970) 263-5130

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

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

The Applicant owns 640 acres of coal within the lease area. Surface ownership of these acres is listed below:

Neal J. Mortensen
c/o UNELCO, Inc.
Aurora, Utah 84620

Roger E. Nielsen and Ruth Nielsen
515 East 240 North
Salina, Utah 84654

Canyon Fuel Company, LLC
225 North 5th Street, 9th Floor
Grand Junction, CO 81501
Telephone: (970) 263-5130

A property ownership map of the permit area and adjacent area is presented as Plate 5-6. The Greens Hollow Lease tract contains approximately 79 acres of Fishlake National Forest, the remainder of the tract's surface is owned by the Manti La Sal Forest .

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 all owners of surface lands contiguous to the permit boundary:

United States of America
Department of Agriculture
U.S. Forest Service
Fishlake National Forest

115 East 900 North
Richfield, Utah 84701

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

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

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.

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 ~~Dugout Canyon Mine, Soldier Canyon Mine, SUFCO Mine, Skyline Mines and Banning Loadout~~ operations.

114 Right-of-Entry Information

Copies of documents granting the legal right to enter and begin underground coal mining activities have not changed with the acquisition. They can be found in Appendix 1.1 Mining and Reclamation Plan for the SUFCO Mine, which is unmodified by this Notice of Change in Ownership and Control Information.

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 U-47080, U-28297, U-62453, U-149084, U-63214, UTU-76195, UTU-91108 (ROW) ,SL-062583, UTU-84102 and State of Utah Coal Lease ML 49443-OBA which grant the right to enter and conduct underground mining operations on the leased premises are presented in Appendix 1-2 Mining and Reclamation Plan for the SUFCO Mine. Appendix 1-2 is unmodified by this Notice of Change in Ownership and Control Information.

Federal Coal Lease SL-062583 grants the right to use lands for the construction and utilization of surface facilities necessary for underground coal mining.

BLM Lease UTU-84102 is in the process of being issued (August 2016). Once the lease/tract is issued to Canyon Fuel Company, LLC a copy of the documents will be incorporated into Appendix 1-2.

The legal description of the SUFCO coal leases:

Federal Coal Lease U-28297 - (716.51 acres) - Approved January 1979
Modified January 2012

T. 21 S., R. 5 E., SLM, Utah
Sec. 32, lot 1, N1/2S1/2
Sec. 33, NW1/4SW1/4
T. 22 S., R. 5 E., SLM, Utah
Sec. 5, W1/2W1/2;
Sec. 7, S1/2NE1 /4, E1/2SW1/4, W1/2SE1/4;
Sec. 8, W1/2NW1/4.

Federal Coal Lease U-062453 - (480 acres) - Approved March 1962

T. 21 S., R. 5 E., SLM, Utah
Sec. 28, SW1/4SW1/4
Sec. 29, SE1/4SE1/4
Sec. 32, N1/2
Sec. 33, W1/2NW1/4

Federal Coal Lease U-0149084 - (240 acres) - Approved June 1966

T. 22 S., R. 4 E., SLM, Utah
Sec. 12, NE1/4 and N1/2SE1/4

Federal Coal Lease SL-062583 - (3,079.83 acres) - Approved September 1941
Modified January 1973
Modified December 2009

T. 21 S., R. 4 E., SLM, Utah
Sec. 36, S1/2
T. 21 S., R. 5 E., SLM, Utah
Sec. 31, all;
T. 22 S., R. 4 E., SLM, Utah
Sec. 1, lots 1 to 4 incl. S1/2N1/2, S1/2
Sec. 2, SE1/4, S1/2SW1/4;
Sec. 3, SE1/4SE1/4;
Sec. 10, E1/2NE1/4, NE1/4SE1/4;

Sec. 11, N1/2, N1/2S1/2;
Sec. 12, NW1/4
T. 22 S., R. 5 E., SLM, Utah
Sec. 6, all;
Sec. 7, N1/2NE1/4, E1/2NW1/4

Federal Coal Lease U-47080 - (1,953.73 acres) - Approved October 1981
Modified December 2009
T. 21 S., R. 4 E., SLM, Utah
Sec. 25, all;
Sec. 35, E1/2, E1/2SW1/4;
Sec. 36, N1/2.
T. 21 S., R. 5 E., SLM, Utah
Sec. 30, lots 2-4, W1/2SE1/4
T. 22 S., R. 4 E., SLM, Utah
Sec. 2, lots 1-4, S1/2NE1/4, S1/2NW1/4, N1/2SW1/4;
Sec. 3, NE1/4SE1/4.
Federal Coal Lease U-63214 - (8,826.34 acres) - Approved July 1989
Modified June 1999
Modified December 2009
Modified May 2011

Tract 1:
T. 21 S., R. 4 E., SLM, Utah
Sec. 12, E1/2SE1/4
Sec. 13, E1/2NE1/4, S1/2
Sec. 14, E1/2SW1/4, SE1/4
Sec. 23, E1/2, E1/2W1/2
Sec. 24, all.
T. 21 S., R. 5 E., SLM, Utah
Sec. 15, W1/2
Secs.16-21, all;
Sec. 22, W1/2
Sec. 26, W1/2NW1/4SW1/4, SW1/4SW1/4
Sec. 27, all;
Sec. 28, N1/2, N1/2SW1/4, SE1/4SW1/4, SE1/4
Sec. 29, E1/2NE1/4, NE1/4SE1/4
Sec. 30, lot 1, N1/2NE1/4
Sec. 33, NE1/4, E1/2NW1/4, NE1/4SW1/4, N1/2SE1/4
Sec. 34, NW1/4NE1/4, NW1/4, NW1/4SW1/4.

Tract 2:
T. 21 S., R. 5 E., SLM, Utah
Sec. 10, SE1/4NW1/4, E1/2SW1/4, E1/2E1/2SW1/4SW1/4, E1/2E1/2NW1/4SW1/4, E1/2E1/2SW1/4NW1/4.

Tract 3:

T. 21 S., R. 4 E., SLM, Utah
Sec. 26, E1/2, E1/2SW1/4;
Sec. 35, NW1/4, W1/2SW1/4.

Federal Coal Lease UTU-76195 - (5,694.66 acres) - Approved October 1999
Modified December 2006

T. 21 S., R. 5 E., SLM
Sec. 2, lots 3,4, S1/2SW1/4, SW1/4SE1/4
Sec. 10, E1/2
Sec. 11, all
Sec. 12, S1/2SW1/4, NW1/4SW1/4
Sec. 13, NW1/4, S1/2
Sec. 14, all
Sec. 15, E1/2
Sec. 22, E1/2
Sec. 23-24, all
Sec. 25, N1/2, N1/2S1/2
Sec. 26, N1/2, NE1/4SW1/4, E1/2NW1/4SW1/4, SE1/4

T. 21 S., R. 6 E., SLM
Sec. 19, lots 3-4, E1/2SW1/4
Sec. 30, lots 1-3, E1/2NW1/4, NE1/4SW1/4

BLM Right-of-Way UTU-91108 (70 Acres) - Approved June 4, 2015

T. 21 S., R. 4 E., SLB&M
Sec. 1,E1/2SE1/4SE1/4, SE1/4NE1/4SE1/4
Sec. 12, E1/2E1/2NE1/4

BLM Lease UTU-84102 (6,696.41 Acres)

T. 20 S., R. 4 E., SLM, Utah
Sec. 36, Lot 4, E1/2NE1/4, NE1/4SE1/4
Sec. 14, E1/2SW1/4, SE1/4
Sec. 23, E1/2, E1/2W1/2
Sec. 24, all.

T. 20 S., R. 5 E., SLM, Utah
Sec. 19, Lots 5-8, E1/2SW1/4, SE1/4
Sec. 20, S1/2
Sec. 21, W1/2, SW1/4
Sec. 28, W1/2
Sec. 29, all;
Sec. 30, all
Sec. 31, all
Sec. 32, N1/2, N1/2S1/2

Sec. 33, NW1/4NW1/4

T. 21 S., R. 4 E., SLM, Utah
Sec. 1, Lots 1 - 4, S1/2
Sec. 2, SE1/4
Sec. 11, E1/2, E1/2W1/2
Sec. 12, NE1/4, W1/2, W1/2SE1/4
Sec. 13, W1/2NE1/4, NW1/4
Sec. 14, NE1/4, E1/2NW1/4

T. 21 S., R. 5 E., SLM, Utah
Sec. 6, all

State of Utah Coal Lease ML 49443-OBA - (2,553.84 acres) - Approved October 2004
Modified June 2015

T. 20 S., R. 5 E., SLB&M
Sec. 32: S1/2S1/2
Sec. 33: S1/2S1/2

T. 21 S., R. 5 E., SLB&M
Sec. 4: Lots 1, 2, 3, 4, S1/2S1/2
Sec. 5: Lots 1, 2, 3, 4, S1/2S1/2
Sec. 7: Lots 1, 2, 3, 4, NE1/4, SE1/4,
Sec. 8: All
Sec. 9: All

Canyon Fuel Company, LLC acquired the right to entry on these properties in the merger described in Section 111 herein above.

In addition, the SUFCO Mine permit area includes certain fee lands owned by Canyon Fuel Company, LLC as follows:

T. 21 S., R. 5 E., SLB&M, Utah
Sec. 29, SW1/4, NW1/4, W1/2NE1/4, W1/2SE1/4
Sec. 30, S1/2NE1/4, E1/2SE1/4
containing 640.00 acres
T. 22 S., R. 4 E., SLB&M, Utah
Sec. 18, NW1/4NE1/4
containing 40 acres

The name of the owner of these fee lands changed from Coastal States Energy Company to Canyon Fuel Company, LLC as a result of the merger transaction described in Section 111 hereinabove.

The SUFCO Mine also uses certain Forest Service lands in its operation for a spring collection system, pumphouse, water transmission line, sanitary discharge line, sanitary drainfield, access road to the sediment pond, and 25 KV powerline. These USFS special use permit areas are shown on Plate 5-6 through portions of:

T. 22 S., R. 4 E., SLB&M, Utah
Sec. 12, S1/2
containing ~~15.32~~ 28.5 acres

The name of the permittee changed from Southern Utah Fuel Company to Canyon Fuel Company, LLC pursuant to the merger described in Section 111 herein above.

The total lease area includes ~~20,991.07~~ 27,687.48 acres of Federal coal leases, 70 acres of BLM R-O-W, 2,553.84 acres of State of Utah coal leases, 640 acres of fee coal leases, the 40 acres waste rock disposal site and ~~15.32~~ 28.5 acres under U.S. Forest Service special use permit for a total of ~~24,310.23~~ 31,019.82 acres.

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 SUFCO Mine was in production 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, see Section 5.2.1.1 for details. Forest Service approval to conduct coal mining and reclamation operations within 100 feet of the Link Canyon forest service road is located in Appendix 1-1 and the newspaper advertisement for public comment is located in Appendix 1-3.

116 Permit Term

The following information is presented to identify permit term requirements and stipulations. Canyon Fuel Company will be operating the SUFCO Mine with continuous miner and longwall mining methods. The estimated number of total surface acres to be affected over the entire mining operation is ~~48.432~~ 49.666 acres.

PERMITTED DISTURBED AREA BOUNDARY	ACTUAL AREA CURRENTLY DISTURBED TO BE RECLAIMED	SITE DESCRIPTION
30.210	17.405	Mine Site, East Spring Canyon
0.967	0.39	Spring Collection Field, Convulsion Cyn. ~~Canyon~~
0.220	0.075	Pump House, Convulsion Canyon
0.784	0.40	Leach Field, Convulsion Canyon
1.595	0.193	Water Tank, East Spring Canyon
0.286	0.017	3 East Portals
1.774	0.70	4 East Portals
0.302	0.017	South Portals
0.396	0.017	Quitchupah Portals
0.287	0.18	Link Canyon Substation No. 1
0.245	0.12	Link Canyon Substation No. 2
0.380	0.18	Link Canyon Portal
~~10.986~~ 12.22	~~8.733~~ 11.29	Waste Rock Disposal Site
0.000	0.00	North Water Mitigation Area
0.000	0.00	Quitchupah Fan and Shaft Site
~~48.432~~ 49.666	~~28.427~~ 30.98	Totals

The legal description of the SUFCO permit area:

Mine Site Facility, Water Tank, South Portals, Spring Collection Field, Pump House, Pipeline, Leachfield (Approximately 64.403 acres)

T. 22 S., R. 4 E., SLBM, Utah
Section 12: A Portion of the following:
E1/2NW1/4, SW1/4NW1/4NE1/4, S1/2

Portals - 3 East, 4 East, Quitchupah and Link Canyon, Link Canyon Substation No. 1 and No. 2 (Approximately 3.368 acres)

T. 21 S., R. 5 E., SLBM, Utah
Section 26: A Portion of the following:
SE1/4SW1/4SW1/4NW1/4, E1/2NW1/4NW1/4SW1/4
SE1/4NE1/4SW1/4SW1/4
Section 29: A Portion of the following:
NW1/4NW1/4SW1/4SE1/4, NE1/4NW1/4SE1/4SW1/4,
NE1/4NE1/4SE1/4SW1/4
Section 32: A Portion of the following:
NE1/4SW1/4SW1/4NE1/4

Waste Rock Disposal Site (Approximately 41.812 acres)

T. 22 S., R. 4 E., SLBM, Utah
Section 18: NW1/4NE1/4

North Water Mitigation Area (Approximately 542.260 acres)

T. 21 S., R. 5 E., SLBM, Utah
Section 2: A Portion of the following:
SW1/4SW1/4SW1/4
Section 3: A Portion of the following:
S1/2SE1/4
Section 10: A Portion of the following:
NE1/4, N1/2NE1/4SE1/4
Section 11: A Portion of the following:
W1/2NW1/4, W1/2SE1/4NW1/4, E1/2SW1/4, NW1/4SW1/4, S1/2SE1/4,
E1/2SW1/4SW1/4, NW1/4SE1/4, S1/2NE1/4SE1/4
Section 12: A Portion of the following:
W1/2SW1/4
Section 14: A Portion of the following:
W1/2NE1/4, NE1/4NW1/4

Quitchupah Fan and Shaft Site (Approximately 68.640 acres)

T. 21 S., R. 5 E., SLBM, Utah
Section 18: A Portion of the following:
S1/2
Section 19: A Portion of the following:
NW1/4NE1/4NE1/4

The permit area boundary, which is shown on Plate 5-6, includes portions of Federal coal leases, fee coal leases, the waste rock disposal site and U.S. Forest Service special use permit areas for a total of 720.483 acres.

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 ~~Dugout Canyon Mine, Soldier Canyon Mine, SUFCO Mine, Skyline Mines and Banning Loadout~~ operations and ~~in Appendix 8-1.~~ on file with the Division.

The newspaper advertisement appears in Appendix 1-3. Verification of the advertisement appearing in the appropriate newspapers will be added to Appendix 1-3 and submitted to the Division no later than 4 weeks after publication.

118 Filing Fee

A photocopy of the receipt is presented in Appendix 1-4 as proof of payment of the permit filing fee.

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

All 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.

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

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

The Applicant believes the information in this permit application to be compete and correct. CFC believes the information in the permit application for its operations to be complete and correct. Reference the Mining and Reclamation Plans for the Dugout Canyon Mine, Soldier Canyon Mine, Sufco Mine, Gordon Creek Mines, Skyline Mine, Fossil Rock Mine and Banning Loadout operations for additional site specific information.

REFERENCES:

U.S. Department of the Interior, Final Supplemental Impact Statement for Leasing and Underground Mining of the Greens Hollow Federal Coal Lease Tract UTU-84102, Sanpete and Sevier Counties, Utah, February 2015

Greens Hollow Tract

APPENDIX 1-1

Legal Right-of-Entry Documents

Authorization ID: RIC245
Contact ID: CANYON FUEL
Expiration Date: 12/31/2034
Use Code: 521

FS-2700-4 (10/09)
OMB No. 0596-0082

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

SPECIAL USE PERMIT

Authority: ORGANIC ADMINISTRATION ACT June 4, 1897

CANYON FUEL COMPANY, L.L.C. C/O BOWIE RESOURCE PARTNERS, LLC ATTN: SCOTT KEHRER 225 N 5TH STREET, SUITE 900 GRAND JUNCTION CO 81501 (hereinafter "the holder") is authorized to use or occupy National Forest System lands in the Fishlake National Forest of the National Forest System, subject to the terms and conditions of this special use permit (the permit).

This permit covers 28.5 acres or .04 miles in the Sec. 12, T. 22 S., R. 4 E., SALT LAKE MERIDIAN , ("the permit area"), as shown on the map attached as Appendix A. This permit issued for the purpose of:

A storage yard to include sediment ponds, coal storage, coal conveyor systems, access roads to sediment ponds and coal storage, a load out facility including scales and a building, a guard shack, and trash storage area for the temporary storage of refuse. Also including a spring collection system, culinary water storage tanks, water transmission lines, sanitary discharge lines, sanitary drainfield, access roads to utilities, 25 Kv powerline, and a pumphouse. The total permit area is 28.5 acres.

TERMS AND CONDITIONS

I. GENERAL TERMS

A. AUTHORITY. This permit is issued pursuant to ORGANIC ADMINISTRATION ACT June 4, 1897 and 36 CFR Part 251, Subpart B, as amended, and is subject to their provisions.

B. AUTHORIZED OFFICER. The authorized officer is the Forest or Grassland Supervisor or a subordinate officer with delegated authority.

C. TERM. This permit shall expire at midnight on 12/31/2034, approx. 20 years from the date of issuance.

D. RENEWAL. This permit is not renewable. Prior to expiration of this permit, the holder may apply for a new permit that would renew the use and occupancy authorized by this permit. Applications for a new permit must be submitted at least 6 months prior to expiration of this permit. Renewal of the use and occupancy authorized by this permit shall be at the sole discretion of the authorized officer. At a minimum, before renewing the use and occupancy authorized by this permit, the authorized officer shall require that (1) the use and occupancy to be authorized by the new permit is consistent with the standards and guidelines in the applicable land management plan; (2) the type of use and occupancy to be authorized by the new permit is the same as the type of use and occupancy authorized by this permit; and (3) the holder is in compliance with all the terms of this permit. The authorized officer may prescribe new terms and conditions when a new permit is issued.

E. AMENDMENT. This permit may be amended in whole or in part by the Forest Service when, at the discretion of the authorized officer, such action is deemed necessary or desirable to incorporate new terms that may be required by law, regulation, directive, the applicable forest land and resource management plan, or projects and activities implementing a land management plan pursuant to 36 CFR Part 215.

F. COMPLIANCE WITH LAWS, REGULATIONS, AND OTHER LEGAL REQUIREMENTS. In exercising the rights and privileges granted by this permit, the holder shall comply with all present and future federal laws and regulations and all present and future state, county, and municipal laws, regulations, and other legal requirements that apply to the permit area, to the extent they do not conflict with federal law, regulation, or policy. The Forest Service assumes no responsibility for enforcing laws, regulations, and other legal requirements that fall under the jurisdiction of other governmental entities.

G. NON-EXCLUSIVE USE. The use or occupancy authorized by this permit is not exclusive. The Forest Service reserves the right of access to the permit area, including a continuing right of physical entry to the permit area for inspection, monitoring, or any other purpose consistent with any right or obligation of the United States under any law or regulation. The Forest Service reserves the right to allow others to use the permit area in any way that is not inconsistent with the holder's rights and privileges under this permit, after consultation with all parties involved. Except for any restrictions that the holder and the authorized officer agree are necessary to protect the installation and operation of authorized temporary improvements, the lands and waters covered by this permit shall remain open to the public for all lawful purposes.

H. ASSIGNABILITY. This permit is not assignable or transferable.

I. TRANSFER OF TITLE TO THE IMPROVEMENTS.

1. Notification of Transfer. The holder shall notify the authorized officer when a transfer of title to all or part of the authorized improvements is contemplated.

2. Transfer of Title. Any transfer of title to the improvements covered by this permit shall result in termination of the permit. The party who acquires title to the improvements must submit an application for a permit. The Forest Service is not obligated to issue a new permit to the party who acquires title to the improvements. The authorized officer shall determine that the applicant meets requirements under applicable federal regulations.

J. CHANGE IN CONTROL OF THE BUSINESS ENTITY.

1. Notification of Change in Control. The holder shall notify the authorized officer when a change in control of the business entity that holds this permit is contemplated.

a. In the case of a corporation, control is an interest, beneficial or otherwise, of sufficient outstanding voting securities or capital of the business so as to permit the exercise of managerial authority over the actions and operations of the corporation or election of a majority of the board of directors of the corporation.

b. In the case of a partnership, limited partnership, joint venture, or individual entrepreneurship, control is a beneficial ownership of or interest in the entity or its capital so as to permit the exercise of managerial authority over the actions and operations of the entity.

c. In other circumstances, control is any arrangement under which a third party has the ability to exercise management authority over the actions or operations of the business.

2. Effect of Change in Control. Any change in control of the business entity as defined in paragraph 1 of this clause shall result in termination of this permit. The party acquiring control must submit an application for a special use permit. The Forest Service is not obligated to issue a new permit to the party who acquires control. The authorized officer shall determine whether the applicant meets the requirements established by applicable federal regulations.

K. CONVEYANCE OF LANDS COVERED BY THIS PERMIT. The authorized officer shall give the holder at least 90 days prior written notice of any pending conveyance of the lands covered by this permit. With the holder's consent, the Forest Service may convey the lands covered by this permit without reserving the right-of-way granted by this permit. If the holder does not consent to conveyance without reservation of the right-of-way, the Forest Service may convey the lands covered by this permit only if the lands are subject to the right-of-way granted by this permit.

II. IMPROVEMENTS

A. LIMITATIONS ON USE. Nothing in this permit gives or implies permission to build or maintain any structure or facility or to conduct any activity, unless specifically authorized by this permit. Any use not specifically authorized by this permit must be proposed in accordance with 36 CFR 251.54. Approval of such a proposal through issuance of a new permit or permit amendment is at the sole discretion of the authorized officer.

B. PLANS. All plans for development, layout, construction, reconstruction, or alteration of improvements in the permit area, as well as revisions to those plans must be prepared by a professional engineer, architect, landscape architect, or other qualified professional based on federal employment standards acceptable to the authorized officer. These plans and plan revisions must have written approval from the authorized officer before they are implemented. The authorized officer may require the holder to furnish as-built plans, maps, or surveys upon completion of the work.

B. CONSTRUCTION. Any construction authorized by this permit shall commence after July 1, 2014 and shall be completed by October 31, 2015.

III. OPERATIONS.

A. PERIOD OF USE. Use or occupancy of the permit area shall be exercised at least 365 days each year.

B. CONDITION OF OPERATIONS. The holder shall maintain the authorized improvements and permit area to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the authorized officer and consistent with other provisions of this permit. Standards are subject to periodic change by the authorized officer when deemed necessary to meet statutory, regulatory, or policy requirements or to protect national forest resources. The holder shall comply with inspection requirements deemed appropriate by the authorized officer.

C. INSPECTION BY THE FOREST SERVICE. The Forest Service shall monitor the holder's operations and reserves the right to inspect the permit area and transmission facilities at any time for compliance with the terms of this permit. The holder's obligations under this permit are not contingent upon any duty of the Forest Service to inspect the permit area or transmission facilities. A failure by the Forest Service or other governmental officials to inspect is not a justification for noncompliance with any of the terms and conditions of this permit.

IV. RIGHTS AND LIABILITIES

A. LEGAL EFFECT OF THE PERMIT. This permit, which is revocable and terminable, is not a contract or a lease, but rather a federal license. The benefits and requirements conferred by this authorization are reviewable solely under the procedures set forth in 36 CFR Part 251, Subpart C, and 5 U.S.C. 704. This permit does not constitute a contract for purposes of the Contract Disputes Act, 41 U.S.C. 601. The permit is not real property, does not convey any interest in real property, and may not be used as collateral for a loan.

B. VALID OUTSTANDING RIGHTS. This permit is subject to all valid outstanding rights. Valid outstanding rights include those derived under mining and mineral leasing laws of the United States. The United States is not liable to the holder for the exercise of any such right.

C. ABSENCE OF THIRD-PARTY BENEFICIARY RIGHTS. The parties to this permit do not intend to confer any rights on any third party as a beneficiary under this permit.

D. SERVICES NOT PROVIDED. This permit does not provide for the furnishing of road or trail maintenance, water, fire protection, search and rescue, or any other such service by a government agency, utility, association, or individual.

E. RISK OF LOSS. The holder assumes all risk of loss associated with use or occupancy of the permit area, including but not limited to theft, vandalism, fire and any fire-fighting activities (including prescribed burns), avalanches, rising waters, winds, falling limbs or trees, and other forces of nature. If authorized temporary improvements in the permit area are destroyed or substantially damaged, the authorized officer shall conduct an analysis to determine whether the improvements can be safely occupied in the future and whether rebuilding should be allowed. If rebuilding is not allowed, the permit shall terminate.

F. DAMAGE TO UNITED STATES PROPERTY. The holder has an affirmative duty to protect from damage the land, property, and other interests of the United States. Damage includes but is not limited to fire suppression costs, damage to government-owned improvements covered by this permit, and all costs and damages associated with or resulting from the release or threatened release of a hazardous material occurring during or as a result of activities of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees on, or related to, the lands, property, and other interests covered by this permit. For purposes of clause IV.F and section V, "hazardous material" shall mean (a) any hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any petroleum product or its derivative, including fuel oil, and waste oils; and (d) any hazardous substance, extremely hazardous substance, toxic substance, hazardous waste, ignitable, reactive or corrosive materials, pollutant, contaminant, element, compound, mixture, solution or substance that may pose a present or potential hazard to human health or the environment under any applicable environmental laws.

1. The holder shall avoid damaging or contaminating the environment, including but not limited to the soil, vegetation (such as trees, shrubs, and grass), surface water, and groundwater, during the holder's use or occupancy of the permit area. If the environment or any government property covered by this permit becomes damaged during the holder's use or occupancy of the permit area, the holder shall immediately repair the damage or replace the damaged items to the satisfaction of the authorized officer and at no expense to the United States.

2. The holder shall be liable for all injury, loss, or damage, including fire suppression, prevention and control of the spread of invasive species, or other costs in connection with rehabilitation or restoration of natural resources associated with the use or occupancy authorized by this permit. Compensation shall include but not be limited to the value of resources damaged or destroyed, the costs of restoration, cleanup, or other mitigation, fire suppression or other types of abatement costs, and all administrative, legal (including attorney's fees), and other costs. Such costs may be deducted from a performance bond required under clause IV.I.

3. The holder shall be liable for damage caused by use of the holder or the holder's heirs, assigns, agents,

employees, contractors, or lessees to all roads and trails of the United States to the same extent as provided under clause IV.F.1, except that liability shall not include reasonable and ordinary wear and tear

G. HEALTH, SAFETY, AND ENVIRONMENTAL PROTECTION. The holder shall promptly abate as completely as possible and in compliance with all applicable laws and regulations any activity or condition arising out of or relating to the authorized use or occupancy that causes or threatens to cause a hazard to public health or the safety of the holder's employees or agents or harm to the environment (including areas of vegetation or timber, fish or other wildlife populations, their habitats, or any other natural resources). The holder shall prevent impacts to the environment and cultural resources by implementing actions identified in the operating plan to prevent establishment and spread of invasive species. The holder shall immediately notify the authorized officer of all serious accidents that occur in connection with such activities. The responsibility to protect the health and safety of all persons affected by the use or occupancy authorized by this permit is solely that of the holder. The Forest Service has no duty under the terms of this permit to inspect the permit area or operations and activities of the holder for hazardous conditions or compliance with health and safety standards.

H. INDEMNIFICATION OF THE UNITED STATES. The holder shall indemnify, defend, and hold harmless the United States for any costs, damages, claims, liabilities, and judgments arising from past, present, and future acts or omissions of the holder in connection with the use or occupancy authorized by this permit. This indemnification provision includes but is not limited to acts and omissions of the holder or the holder's heirs, assigns, agents, employees, contractors, or lessees in connection with the use or occupancy authorized by this permit which result in (1) violations of any laws and regulations which are now or which may in the future become applicable, and including but not limited to those environmental laws listed in clause V.A of this permit; (2) judgments, claims, demands, penalties, or fees assessed against the United States; (3) costs, expenses, and damages incurred by the United States; or (4) the release or threatened release of any solid waste, hazardous waste, hazardous materials, pollutant, contaminant, oil in any form, or petroleum product into the environment. The authorized officer may prescribe terms that allow the holder to replace, repair, restore, or otherwise undertake necessary curative actions to mitigate damages in addition to or as an alternative to monetary indemnification.

I. BONDING. The authorized officer may require the holder to furnish a surety bond or other security for any of the obligations imposed by the terms and conditions of this permit or any applicable law, regulation, or order.

V. RESOURCE PROTECTION

A. COMPLIANCE WITH ENVIRONMENTAL LAWS. The holder shall in connection with the use or occupancy authorized by this permit comply with all applicable federal, state, and local environmental laws and regulations, including but not limited to those established pursuant to the Resource Conservation and Recovery Act, as amended, 42 U.S.C. 6901 et seq., the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq., the Oil Pollution Act, as amended, 33 U.S.C. 2701 et seq., the Clean Air Act, as amended, 42 U.S.C. 7401 et seq., CERCLA, as amended, 42 U.S.C. 9601 et seq., the Toxic Substances Control Act, as amended, 15 U.S.C. 2601 et seq., the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, 7 U.S.C. 136 et seq., and the Safe Drinking Water Act, as amended, 42 U.S.C. 300f et seq.

B. VANDALISM. The holder shall take reasonable measures to prevent and discourage vandalism and disorderly conduct and when necessary shall contact the appropriate law enforcement officer.

C. PESTICIDE USE. Pesticides may not be used outside of buildings to control undesirable woody and herbaceous vegetation (including aquatic plants), insects, rodents, fish, and other pests and weeds without prior written approval from the authorized officer. A request for approval of planned uses of pesticides shall be submitted annually by the holder on the due date established by the authorized officer. The report shall cover a 12-month period of planned use beginning 3 months after the reporting date. Information essential for review shall be provided in the form specified. Exceptions to this schedule may be allowed, subject to emergency request and approval, only when unexpected outbreaks of pests or weeds require control measures that were not anticipated at the time an annual report was submitted. Only those materials registered by the U.S. Environmental Protection Agency for the specific purpose planned shall be considered for use on National Forest System lands. Label instructions and all applicable laws and regulations shall be strictly followed in the application of pesticides and disposal of excess materials and containers.

D. ARCHAEOLOGICAL-PALEONTOLOGICAL DISCOVERIES. The holder shall immediately notify the authorized officer of all antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered in connection with the use and occupancy authorized by this permit. The holder shall leave these discoveries intact and in place until directed otherwise by the authorized officer. Protective and mitigative measures specified by the authorized officer shall be the responsibility of the holder.

E. NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION. In accordance with 25 U.S.C. 3002(d) and 43 CFR 10.4, if the holder inadvertently discovers human remains, funerary objects, sacred objects, or objects of cultural patrimony on National Forest System lands, the holder shall immediately cease work in the area of the discovery and shall make a reasonable effort to protect and secure the items. The holder shall immediately notify the authorized officer by telephone of the discovery and shall follow up with written confirmation of the discovery. The activity that resulted in the inadvertent discovery may not resume until 30 days after the authorized officer certifies receipt of the written confirmation, if resumption of the activity is otherwise lawful, or at any time if a binding written agreement has been executed between the Forest Service and the affiliated Indian tribes that adopts a recovery plan for the human remains and objects.

F. PROTECTION OF HABITAT OF THREATENED, ENDANGERED, AND SENSITIVE SPECIES. The location of sites within the permit area needing special measures for protection of plants or animals listed as threatened or endangered under the Endangered Species Act (ESA) of 1973, 16 U.S.C. 1531 et seq., as amended, or identified as sensitive or otherwise requiring special protection by the Regional Forester under Forest Service Manual (FSM) 2670, pursuant to consultation conducted under section 7 of the ESA, may be shown on the ground or on a separate map. The map shall be attached to this permit as an appendix. The holder shall take any protective and mitigative measures specified by the authorized officer. If protective and mitigative measures prove inadequate, if other sites within the permit area containing threatened, endangered, or sensitive species or species otherwise requiring special protection are discovered, or if new species are listed as threatened or endangered under the ESA or identified as sensitive or otherwise requiring special protection by the Regional Forester under the FSM, the authorized officer may specify additional protective and mitigative measures. Discovery of these sites by the holder or the Forest Service shall be promptly reported to the other party.

G. CONSENT TO STORE HAZARDOUS MATERIALS. The holder shall not store any hazardous materials at the site without prior written approval from the authorized officer. This approval shall not be unreasonably withheld. If the authorized officer provides approval, this permit shall include, or in the case of approval provided after this permit is issued, shall be amended to include specific terms addressing the storage of hazardous materials, including the specific type of materials to be stored, the volume, the type of storage, and a spill plan. Such terms shall be proposed by the holder and are subject to approval by the authorized officer.

1. If the holder receives consent to store hazardous material, the holder shall identify to the Forest Service any hazardous material to be stored at the site. Such identification information shall be consistent with column (1) of the table of hazardous materials and special provisions enumerated at 49 CFR 172.101 whenever the hazardous material appears in that table. For hazard communication purposes, the holder shall maintain Material Safety Data Sheets for any stored hazardous chemicals, consistent with 29 CFR 1910.1200(c) and (g). In addition, all hazardous materials stored by the holder shall be used, labeled, stored, transported, and disposed of in accordance with all applicable federal, state, and local laws and regulations.

2. The holder shall not release any hazardous material as defined in clause IV.F. onto land or into rivers, streams, impoundments, or natural or man-made channels leading to them. All prudent and safe attempts must be made to contain any release of these materials. The authorized officer in charge may specify specific conditions that must be met, including conditions more stringent than federal, state, and local regulations, to prevent releases and protect natural resources.

H. CLEANUP AND REMEDIATION

1. The holder shall immediately notify all appropriate response authorities, including the National Response Center and the authorized officer or the authorized officer's designated representative, of any oil discharge or of the release of a hazardous material in the permit area in an amount greater than or equal to its reportable quantity, in accordance with 33 CFR Part 153, Subpart B, and 40 CFR Part 302. For the purposes of this requirement, "oil" is as defined by section 311(a)(1) of the Clean Water Act, 33 U.S.C. 1321(a)(1). The holder shall immediately notify the authorized officer or the authorized officer's designated representative of any release or threatened release of any hazardous material in or near the permit area which may be harmful to public health or welfare or which may adversely affect natural resources on federal lands.

2. Except with respect to any federally permitted release as that term is defined under Section 101(10) of CERCLA, 42 U.S.C. 9601(10), the holder shall clean up or otherwise remediate any release, threat of release, or discharge of hazardous materials that occurs either in the permit area or in connection with the holder's activities in the permit area, regardless of whether those activities are authorized under this permit. The holder shall perform cleanup or remediation immediately upon discovery of the release, threat of release, or discharge of hazardous materials. The holder shall perform the cleanup or remediation to the satisfaction of the authorized officer and at no expense to the United States. Upon revocation or termination of this permit, the holder shall deliver the site to the Forest Service free and clear of contamination.

I. CERTIFICATION UPON REVOCATION OR TERMINATION. If the holder uses or stores hazardous materials at the site, upon revocation or termination of this permit the holder shall provide the Forest Service with a report certified by a professional or professionals acceptable to the Forest Service that the permit area is uncontaminated by the presence of hazardous materials and that there has not been a release or discharge of hazardous materials upon the permit area, into surface water at or near the permit area, or into groundwater below the permit area during the term of the permit. This certification requirement may be waived by the authorized officer when the Forest Service determines that the risks posed by the hazardous material are minimal. If a release or discharge has occurred, the professional or professionals shall document and certify that the release or discharge has been fully remediated and that the permit area is in compliance with all federal, state, and local laws and regulations.

VI. LAND USE FEE AND ACCOUNTING ISSUES

A. LAND USE FEES. The holder shall pay an initial annual land use fee as shown on the bill for collection for the period from January 1, 2015 to December 31, 2015, and thereafter on the date shown on the bill for collection, shall pay an annual land use fee as determined by the market value of the authorized use.

B. MODIFICATION OF THE LAND USE FEE. The land use fee may be revised whenever necessary to reflect the market value of the authorized use or occupancy or when the fee system used to calculate the land use fee is modified or replaced.

C. FEE PAYMENT ISSUES.

1. Crediting of Payments. Payments shall be credited on the date received by the deposit facility, except that if a payment is received on a non-workday, the payment shall not be credited until the next workday.

2. Disputed Fees. Fees are due and payable by the due date. Disputed fees must be paid in full. Adjustments will be made if dictated by an administrative appeal decision, a court decision, or settlement terms.

3. Late Payments

(a) Interest. Pursuant to 31 U.S.C. 3717 et seq., interest shall be charged on any fee amount not paid within 30 days from the date it became due. The rate of interest assessed shall be the higher of the Prompt Payment Act rate or the rate of the current value of funds to the Treasury (i.e., the Treasury tax and loan account rate), as prescribed and published annually or quarterly by the Secretary of the Treasury in the Federal Register and the Treasury Fiscal Requirements Manual Bulletins. Interest on the principal shall accrue from the date the fee amount is due.

(b) Administrative Costs. If the account becomes delinquent, administrative costs to cover processing and handling the delinquency shall be assessed.

(c) Penalties. A penalty of 6% per annum shall be assessed on the total amount that is more than 90 days delinquent and shall accrue from the same date on which interest charges begin to accrue.

(d) Termination for Nonpayment. This permit shall terminate without the necessity of prior notice and opportunity to comply when any permit fee payment is 90 calendar days from the due date in arrears. The holder shall remain responsible for the delinquent fees.

4. Administrative Offset and Credit Reporting. Delinquent fees and other charges associated with the permit shall be subject to all rights and remedies afforded the United States pursuant to 31 U.S.C. 3711 et seq. and common law. Delinquencies are subject to any or all of the following:

(a) Administrative offset of payments due the holder from the Forest Service.

(b) If in excess of 60 days, referral to the Department of the Treasury for appropriate collection action as provided by 31 U.S.C. 3711(g)(1).

(c) Offset by the Secretary of the Treasury of any amount due the holder, as provided by 31 U.S.C. 3720 et seq.

(d) Disclosure to consumer or commercial credit reporting agencies.

VII. REVOCATION, SUSPENSION, AND TERMINATION

A. REVOCATION AND SUSPENSION. The authorized officer may not revoke or suspend this permit without the consent of the head of the agency that holds this permit.

B. APPEALS AND REMEDIES. Written decisions by the authorized officer relating to administration of this permit are subject to administrative appeal pursuant to 36 CFR Part 251, Subpart C, as amended. Revocation or suspension of this permit shall not give rise to any claim for damages by the holder against the Forest Service.

C. TERMINATION. This permit shall terminate when by its terms a fixed or agreed upon condition, event, or time occurs without any action by the authorized officer. Examples include but are not limited to expiration of the permit by its terms on a specified date and termination upon change of control of the business entity. Termination of this permit shall not require notice, a decision document, or any environmental analysis or other documentation. Termination of this permit is not subject to administrative appeal and shall not give rise to any claim for damages by the holder against the Forest Service.

D. RIGHTS AND RESPONSIBILITIES UPON REVOCATION OR TERMINATION WITHOUT RENEWAL. Upon revocation or termination of this permit without renewal of the authorized use, the holder shall remove all structures and improvements, except those owned by the United States, within a reasonable period prescribed by the authorized officer and shall restore the site to the satisfaction of the authorized officer. If the holder fails to remove all structures and improvements within the prescribed period, they shall become the property of the United States and may be sold, destroyed, or otherwise disposed of without any liability to the United States. However, the holder shall remain liable for all costs associated with their removal, including costs of sale and impoundment, cleanup, and restoration of the site.

VIII. MISCELLANEOUS PROVISIONS

A. MEMBERS OF CONGRESS. No member of or delegate to Congress or resident commissioner shall benefit from this permit either directly or indirectly, except to the extent the authorized use provides a general benefit to a corporation.

B. CURRENT ADDRESSES. The holder and the Forest Service shall keep each other informed of current mailing addresses, including those necessary for billing and payment of land use fees.

C. SUPERSEDED PERMIT. This permit supersedes a special use permit designated CANYON FUEL COMPANY, L.L.C., RIC98 and RIC407802, dated 01/26/2006 and 7/31/1986.

D. SUPERIOR CLAUSES. If there is a conflict between any of the preceding printed clauses and any of the following clauses, the preceding printed clauses shall control.

E. Improvement Relocation (X33). This authorization is granted with the express understanding that should future location of United States Government-owned improvements or road rights-of-way require the relocation of the holder's improvements, such relocation will be done by, and at the expense of, the holder within a reasonable time as specified by the authorized officer.

This permit is accepted subject to the conditions set out above.

Date:	**CORPORATE NAME**
(CORPORATE SEAL)	
By: [signature] ~~(Vice) President~~ CHIEF OPERATING OFFICER	
ATTEST: [signature]	
(Assistant) Secretary	

The following certificate shall be executed by the secretary or assistant secretary of the corporation:

I, Brian Settles, certify that I am the Secretary of the corporation that executed the above permit; that Eugene DiClaudio, who signed said permit on behalf of said Corporation was then of said Corporation; that I know his/her signature on said permit is genuine; and that said permit was duly signed, sealed, and attested to for and on behalf of said Corporation by authority of its governing body.

(CORPORATE SEAL)	
(Assistant Secretary)	
U. S. DEPARTMENT OF AGRICULTURE Forest Service	
By: (Authorized Officer Signature)	
Fishlake National Forest	
Allen Rowley, Forest Supervisor	
Date:	

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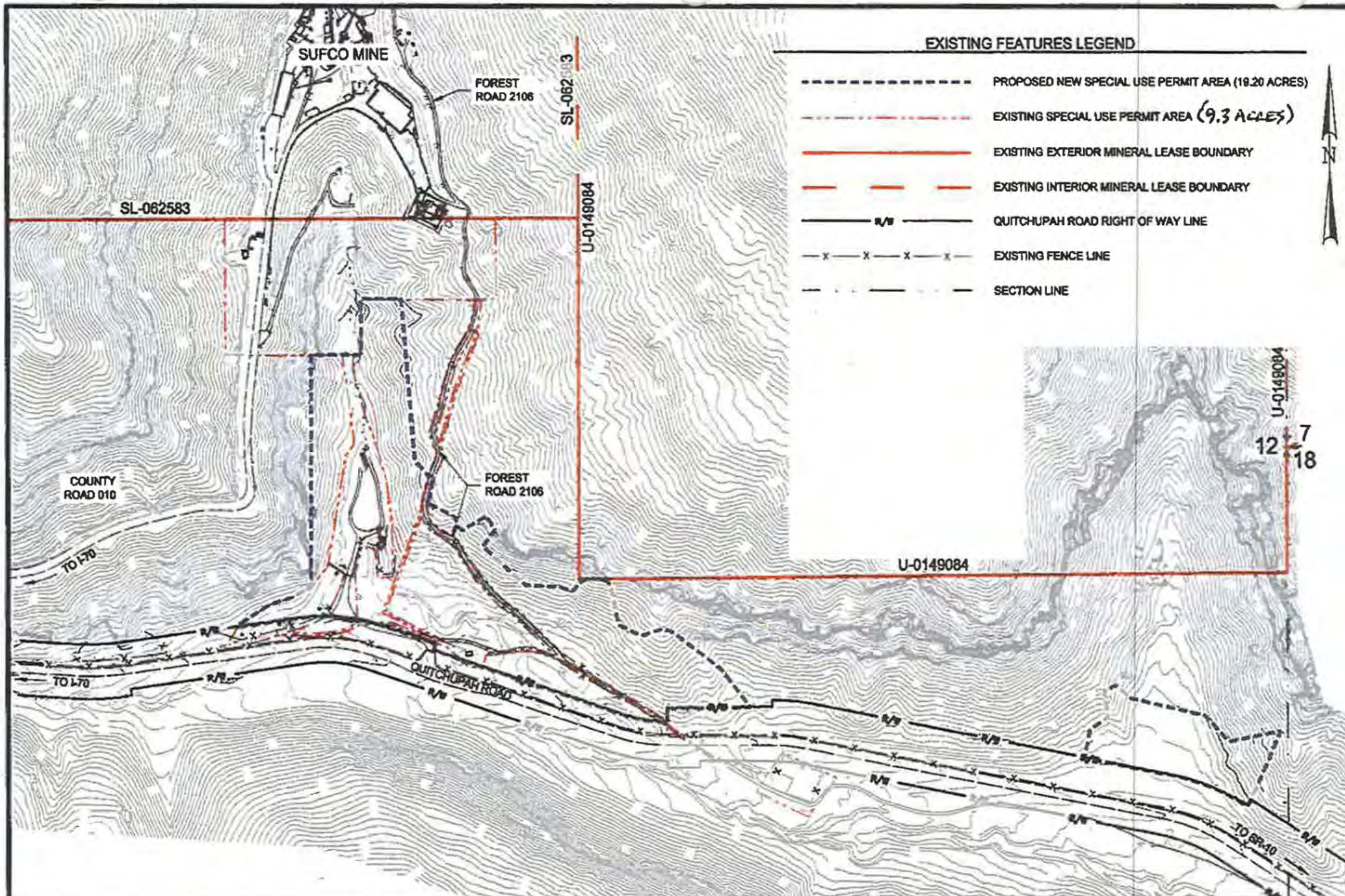


Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 - Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

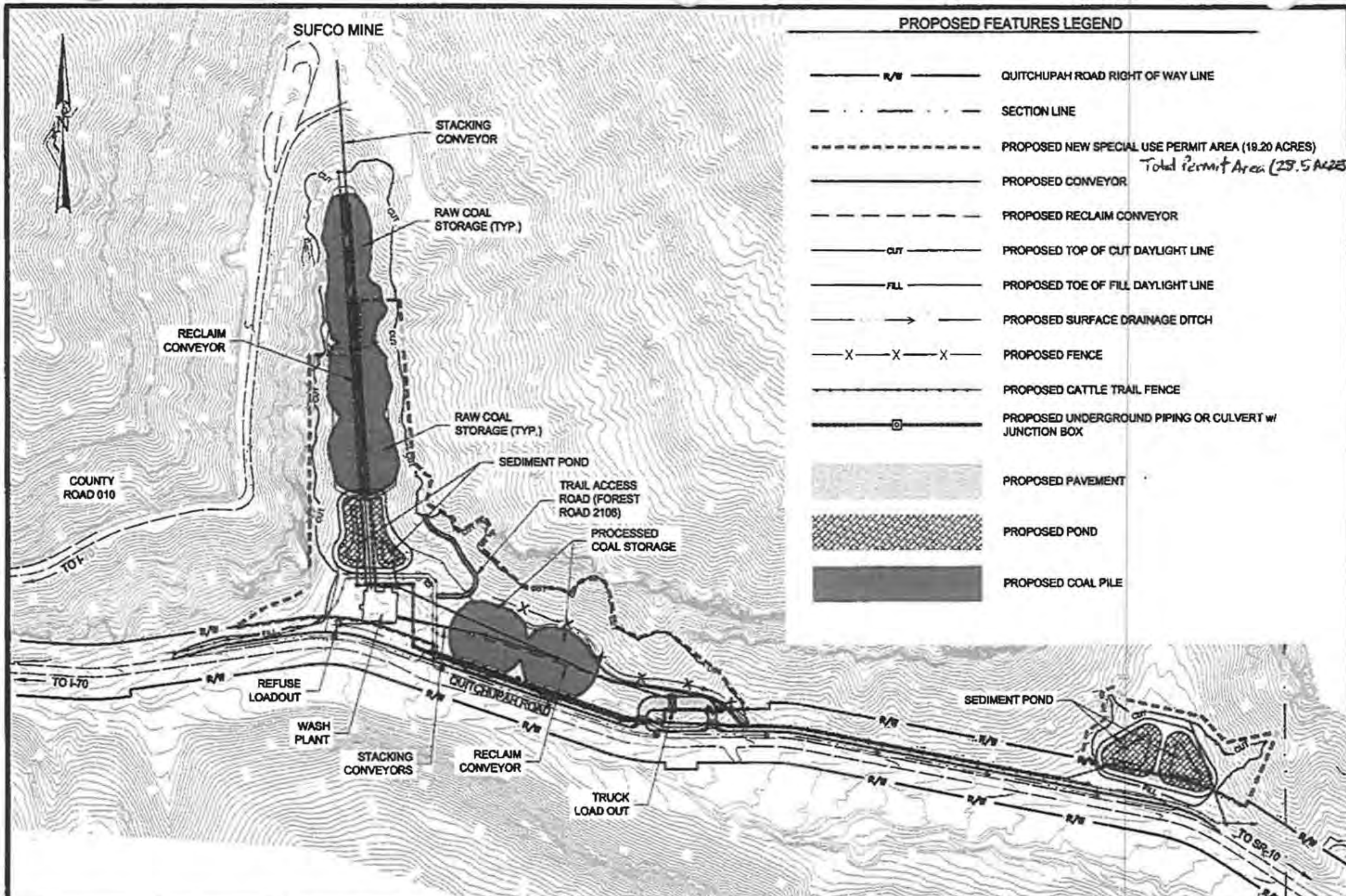
Sufco Convulsion Canyon - CPP

Special Use Permit Boundary Exhibit - Existing Features

SCALE: 1" = 500'	DATE: 2/7/2014	DRAWN BY: T.B.\K.B.
ENGINEER: K.B.B.	CHECKED BY: K.B.\J.B.	PROJ: 0114-004
FILE NAME: M:\PROJ\0114-004\dwg\FS-SUP.dwg		

SHEET NO.
EX-01

Existing Features   RIC 245   Appendix A   Page 1



Canyon Fuel Company, LLC
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597 South SR 24 - Salina, UT 84654
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(435) 286-4499 Fax

Sufco Convulsion Canyon – CPP

Special Use Permit Boundary Exhibit – Proposed Features

SCALE: 1" = 500'	DATE: 2/7/2014	DRAWN BY: T.B.\K.B.	SHEET NO. EX-02
ENGINEER: K.B.B.	CHECKED BY: K.B.\J.B.	PROJ: 0114-004	
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THE ENTIRE TEXT FOR EACH CHAPTER IS INCLUDED IN THIS SUBMITTAL FOR EASE OF REVIEW.

ONCE APPROVED ONLY PAGES WITH CHANGES WILL BE SUBMITTED.

CHAPTER 2

SOILS

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Appendix

CHAPTER 2

SOILS

2.10 Introduction

This chapter and Volume 3 of this M&RP contains all pertinent information relating to identification, management, and reclamation activities associated with the soil resources present in the disturbed area of the SUFCO Mine.

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

2.20 Environmental Description

The SUFCO Mine area lies in central Utah at the southern end of the Wasatch Plateau. Topography is dominated by plateaus separated by deeply incised canyons. Canyon walls are generally composed of laterally continuous (several thousand feet) ledge-forming sandstones, interbedded with slope forming shales and siltstones. Topography in the SUFCO Mine area ranges from 6500 to about 9,000 feet above sea level. Soils are generally not cultivated due to their thin nature, shortage of irrigation water, and a short growing season. Residual and colluvial soils are present at the SUFCO Mine surface facilities area. These soils have formed from residual sandstone and shale particles that mixed as they migrated down slope. Soils are usually very shallow, consisting predominantly of sand and silty sand loams which have high percolation rates. The soils are highly susceptible to wind erosion. The inherent erosion hazard from water is low. Rock outcrops consist of alternating layers of sandstone and shale. Subordinate amounts of coal and limestone are also present. The landscape is steep and rocky with massive sandstone ledges, and siltstone/shale slopes. Surface and subsurface layers are often rocky.

2.2.1 Prime Farmland Investigation

No prime farmland exists in the SUFCO Mine disturbed area, Link Canyon disturbed area, or in any of its lease areas. Mining activities will not impact prime farmland. In compliance with R645-302-313, a pre-application investigation was conducted by the Applicant to determine if any prime farmland would be impacted by the project. Based on the federal criteria for determining the presence or absence of prime farmland, the Convulsion Canyon area, Link Canyon, the Pines Tract area, and the SITLA Muddy Tract area cannot be classified as prime farmland. Consultation with Dr. Theron B. Hutchings, State Soil Scientist for the Soil Conservation Service, substantiated the absence of prime farmland in the Convulsion Canyon and Link Canyon areas. (Appendix 2-1).

2.2.2 Soil Survey

A Level I soil survey of the entire SUFCO Mine disturbed area, including the Link Canyon Substations No. 1 and 2 , has been conducted. Soil survey data are presented in Appendix 2-2 for the majority of the permit area, Appendix 2-6 for the Link Canyon Substation areas, and are herein summarized in Sections 2.2.2.1 through 2.2.2.3. Survey data includes the following information: taxonomic classification, horizon name and depth, dry and moist color, texture (percent sand, silt, and clay), class, structure, percent rock fragments and organic matter, pH, effervescence, EC, and solubility of calcium, magnesium, and sodium (Appendices 2-2 and 2-6). A cross-reference list of map unit, soil taxonomic classification, and sample site appears in pages 17 through 19 of Appendix 2-2.

A site specific soil survey will be completed for the Overflow Pond prior to disturbance and this information will be utilized in determining topsoil salvage depth. The results of this soil survey will be included in the as-built addendum to be included in Appendix 2-2.

An Order 2 soil survey has been completed for the Link Canyon Substation No. 1 disturbed area and is included in Appendix 2-2. Additionally, an Order 1 soil survey was conducted of the substation Nos. 1 and 2 pad areas and the results are included in Appendix 2-6.

An Order 3 soil survey has been conducted for the Pines Tract and the results are included in Appendix 2-8. (Plate 2-2)

An Order 3 soil survey has been conducted for the SITLA Muddy Tract and the results are included in Appendix 2-10. (Plate 2-3). Soils associated with the 70 Acre BLM Right of Way are part of the Order 3 soil survey located in Appendix 2-10.

2.2.2.1 Soils Map

Plates 2-1 and 2-2 delineates the soil types present in the disturbed and adjacent areas.

2.2.2.2 Soil Identification

Soils present in the narrow V-shaped East Spring Canyon, which lie within and immediately adjacent to the disturbed area of the SUFCO Mine have been identified, characterized, and their spatial occurrences documented (Appendix 2-2). Four soil types are present in the disturbed area, and are herein referred to as soil types O, W, T, and X (Plate 2-1). Soil type O is a loamy-skeletal, mixed, frigid Ustic Torriorthent. Soil W is a loamy-skeletal, mixed, frigid Typic Xerothent. Soil type T is a loamy-skeletal, mixed, frigid, Calcixerollic Xerochrept. Soil X is a complex composed of both a clayey-skeletal, mixed, frigid, shallow Lithic Calcixeroll, and a fine, mixed, frigid Mollic Haploxeralf.

Analytical and field methodology utilized in characterizing these soil types and their soil horizons are found in pages 13 and 14 of Appendix 2-2. Soils were classified to family unit using the Soil Conservation Service's classification system (Johnson, 1975).

2.2.2.3 Soil Description

Soil Type O

Soil type O is found at the north end of the disturbed area, in the area of the confluence of the Mud Spring Hollow and East Spring Canyon drainages (Plate 2-1). The taxonomic classifications of Soil O are that of a loamy-skeletal, mixed, frigid Ustic Torriorthent. This soil is found on slopes with grades of 60 percent or greater; consists of well-drained soils that have formed from residuum and colluvium; and supports Pinyon, Juniper, and Mountain Mahogany vegetative growth. The water holding capacity is 3.5 inches.

The A soil horizon ranges from 0 to 2 inches in depth and is a sandy clay loam composed of about 52% sand, 22% silt, and 26% clay. The dominant color is a pale brown (10YR 6/3) when dry, and a dark grayish brown (10YR 4/2) when moist. Rock fragments (predominantly gravel) account for 15% by volume of this horizon. A pH of 7.66, EC of 740 mmhos/cm, and organic matter values of 2.22% are present. Solubility values (ppm) of Ca, Mg, and Na, are 116.3, 14.4, and 6.7, respectively.

The AC soil horizon ranges from 2 to 12 inches in depth and is a sandy clay loam composed of approximately 50% sand, 18% silt, and 32% clay. Predominant color is a yellowish brown (10YR 5/4) dry, and a dark grayish brown (10YR 4/2) wet. Rock fragments make up about 45% (15% gravel, 10% cobbles, 20% stones) of the AC horizon by volume. A pH of 7.73, an EC of 940 mmhos/cm, and an organic matter percent of 2.2% are common. Solubility values (ppm) of Ca, Mg, and Na, are 150, 18, and 6, respectively.

The C soil horizon ranges in depth from 12 to 31 inches. This horizon is also a sandy clay loam composed of 45% sand, 23% silt, and 32% clay. Soil color is light yellowish brown (2.5Y 6/4) when wet. Rock fragments account for 30% (20% gravel, 5% cobbles, 5% stones) of the C soil horizon by volume. A pH value of 7.92, EC of 560 mmhos/cm, and an organic matter percent of 0.54 are present. Solubility values (ppm) of Ca, Mg, and Na, are 83, 12, and 9, respectively. Bedrock is encountered at a depth of 31 inches.

Soil Type W

Soil type W is found along the western edge of the disturbed area on an east facing slope with a grade of 60% or more (Plate 2-1). The taxonomic classifications of Soil W are that of a loamy-skeletal, mixed, frigid Typic Xerothent. Soil W supports vegetation consisting of sage-grass and mountain brush in this area. This soil consists of excessively well drained soils that have formed in residuum and colluvium. Rock outcrops comprise 30% of the mapped area containing soil type W.

The A1 soil horizon occurs from the surface to a depth of 4 inches. This surface soil horizon is a sandy clay loam composed of 53% sand, 21% silt, and 26% clay; rock fragments compose about 80% (40% gravels, 40% cobbles) of its volume. The A1 horizon has a brown to dark brown color (10YR 4/3) when moist. A pH value of 7.5, EC of 3300 mmhos/cm, and a percent organic matter of 1.54 are present. The solubilities of Ca, Mg, and Na, are 430, 118, and 42 ppm, respectively.

The A1 soil is underlain by a brown to dark brown (10YR 4/3) C soil horizon. The C soil occurs between depths of 4 to greater than 60 inches. It is also a sandy clay loam with sand, silt, and clay percentages of 53, 21, and 26, respectively. Rock fragments compose about 45% by volume (25% gravel, 10% cobbles, 10% stones) of this soil horizon. Solubilities of Ca, Mg, and Na are identical to those in the A1 horizon.

Soil Type T

Soil type T is found in the south-central region of the disturbed area and encompasses the original drainage channel of the East Spring Canyon (Plate 2-1). This unit consists of excessively well-drained soils that have formed in colluvium and residuum. Slopes range in excess of 60%. Soil T is classified as a loamy-skeletal, mixed, frigid, Calcixerollic Xerochrept. Rock outcrops comprise 30% of the mapped area containing soil type T. The water holding capacity of the soil is 4 inches. Soil T supports pinyon pine, juniper, and wild rye vegetation.

The surficial A1 soil horizon ranges in depth from 0 to 2 inches. This horizon is a sandy clay loam, composed of 45% sand, 23% silt, and 32% clay. Soil color is yellowish brown (10YR 5/4) when moist. Rock fragments account for only 5% (gravel) by volume. A pH value of 7.57, EC of 1110 mmhos/cm, and an organic matter percent of 5.57% are present. Solubility values (ppm) of Ca, Mg, and Na, are 149, 29, and 8, respectively.

The B1 horizon, a clay loam, occurs between depths of 2 to 12 inches, and is composed of 37% sand, 29% silt, and 34% clay. Rock fragments compose 55% (10% gravel, 5% cobbles, 40% stone) by volume of this soil resource. When moist the B1 horizon is brown to dark brown (10YR 4/3) in color. Geochemical tests reveal a pH of 7.45, an EC of 1340 mmhos/cm, and an organic matter percent of 4.07. Solubility values of Ca, Mg, and Na, are 182, 35, and 7.4 ppm, respectively.

The underlying B2 soil horizon ranges from depths of 12 to 24 inches, and is brown (10YR 5/3) in color. It is a clay loam composed of 35% sand, 27% silt, and 38% clay. Rock fragments account for 45% (40% gravel, 5% cobble) by volume of this soil horizon. PH value of 7.66, an EC of 820 mmhos/cm, and organic matter values of 2.63 are present. Ca, Mg, and Na solubility concentrations are 99, 20, and 9 ppm, respectively.

The basal yellowish brown (10YR 5/4) C soil horizon occurs from 24 to 58 inches below ground level. Soil C is also a clay loam, with sand comprising 37%, silt 27%, and clay 35%. Rock fragments make up 50% of this soil horizon, with stones accounting for 40%, gravel 5%, and cobbles 5%. Solubility concentrations of Ca, Mg, and Na are 220, 80, and 37 ppm, respectively.

<u>Soil Type X</u>

Soil X lies along the eastern edge and in the north-central region of the disturbed area (Plate 2-1). This soil is a complex consisting of two soil types: (1) a clayey-skeletal, mixed, frigid, shallow Lithic Calcixeroll, and (2) a fine, mixed, frigid Mollic Haploxeralf. The former soil comprises approximately 70% of the soil cover in this region, the latter soil type accounts for about 20%, with about 10% of the area covered with rock outcrop. Both soil types support pinyon pine and juniper trees.

The Lithic Calcixeroll soil is composed of A1, AC, and Cca soil horizons. The A1 horizon occurs from the surface to a depth of 4 inches below the surface and is dark brown (7.5YR 3/2). It is a clay loam composed of 43% sand, 29% silt, and 28% clay. Rock fragments (gravel) comprise 25% by volume this horizon. An organic matter content of 7%, pH value of 7.44, and an EC of 1280 mmhos/cm are present. Soluble concentrations of Ca, Mg, and Na are 205, 27, and 6.6 ppm, respectively.

The AC soil horizon occurs between 4 to 8 inches below ground level, and is predominately a clay composed of 33% sand, 25% silt, and 42% clay. Its color when moist is dark brown (7.5YR 3/2). Gravel makes up 20% of this horizon, by volume. Organic matter accounts for about 5% of this horizon. PH and EC values of 7.9 and 510 mmhos/cm are present. Ca, Mg, and Na soluble concentrations are 73, 19, and 3 ppm, respectively.

The underlying Cca soil horizon extends from 8 inches to depths of about 17 inches, where bedrock is encountered. The Cca horizon is a reddish brown clay. Clay comprises 42% of this horizon; subordinate amounts of sand (35%) and silt (23%) are also present. Rock fragments account for 55% (40% gravel, 15% cobbles) of this zone. EC values of 380 mmhos/cm, along with a pH of 7.97, and an organic matter percent of only 1.21% are present. Soluble concentrations for Ca, Mg, and Na are 10, 10, and 6 ppm, respectively.

The Mollic Haploxeralf soil is characterized by an A, AC, and Cca soil horizons. The surficial A horizon extends to 5 inches below ground level, and is a very dark brown (10YR 2/2) sandy clay loam. It is typically composed of 59% sand, 15% silt, and 26% clay. Gravel accounts for only 5% by volume of this horizon. Percent organic matter is about 7%. A pH of 7.63 and an EC of 1620 mmhos/cm are present. The soluble concentrations (ppm) of Ca, Mg, and Na are 168, 72, and 26, respectively.

The underlying AC soil zone occurs between 5 to 14 inches below the surface, and is a pale brown (10YR 6/3) clay. Clay is the dominant constituent comprising 44% of this zone, silt (39%) and sand (17%) are also present. Rock fragments make up 20% (5% gravel, 15% cobbles) of this horizon, by volume. An organic matter value of 3.8%, a pH level of 7.48, and an EC of 6340 mmhos/cm characterize this soil horizon. Solubilities of Ca, Mg, and Na are 517, 279, and 317 ppm, respectively.

The basal soil horizon, Cca, a light brownish gray clay, typically extends to depths of 34 inches where bedrock is encountered. Cca is composed of 52% clay, 37% silt, and 11% sand. Rock fragments comprise 40% (10% gravel, 20% cobbles, 10% stones) of this horizon. Percent organic matter is only 1.7. PH and EC values are 7.87 and 9590 mmhos/cm, respectively.

Overflow Pond Soils

A general description of the soils located in the Overflow Pond area will be provided in Appendix 2-2.

Link Canyon Soils

A description of the soils located in the Link Canyon Substation Nos. 1 and 2 disturbed areas is provided in Appendix 2-6.

Link Canyon Mine Portals

A description of the soils located in the Link Canyon Mine Portals area is provided in Appendix 2-9. The description of the soils was prepared by Dan Larsen, a soils scientist with EIS Environmental and Engineering Consultants.

Pines Tract

The general description of the soils within the Pines Tract is provided in Appendix 2-8.

SITLA Muddy Tract and Greens Hollow Tract

The general description of the soils within the SITLA Muddy Tract and Greens Hollow Tract is provided in Appendix 2-10.

2.2.2.4 Soil Productivity

In areas where soil disturbance has resulted from mining activities, the soils have lost their native identities. In most cases the soils have been quite thoroughly mixed. As a result, soil textures and horizons have been altered. Textures are now primarily loams and silty clay loams; depths over indurated material or shale are generally greater than 30 inches, except along "cut" slopes of the mountain where geologic strata are exposed.

As a result of this disturbance in "fill" areas, the potential for reclamation has been enhanced. The soils are deeper and the resulting textures are more desirable for plant growth.

Saturation percentages are unavailable. When the original sampling and analyses of soils for the portal yard area were completed, saturation percentage was not required by the regulatory agencies.

Electrical conductivity and other analytical data for soils of the disturbed area, soil types O, W, T, and X, are found in Tables 51, 56, 53, 57, and 58, of Appendix 2-2, respectively. These data reveal a high percentage of rock fragments which may limit fertility for both topsoil and subsoil. Vegetation associated with these soils regarding soil productivity are presented (as recommended by the Soil Conservation Service) in Appendix 2-2 and discussed in Chapter 3 of the Mining Reclamation Plan (MR&P).

2.2.3 Prime Farmland Soil Characterization

No prime farmland exists in the permit area (see Section 2.2.1).

2.2.4 Substitute Topsoil

During final reclamation suitable growth medium/substitute topsoil will be collected at potential locations such as the upper sediment pond dam, the fill slope above the upper sediment pond and soil resources used to construct the original surface pad. The applicant has no sound method for calculating the quantity of growth medium/substitute topsoil available from these potential locations. The preconstruction topography is poor or non-existent and a record of the quantity of material used for the construction of these locations is not available. A random composite sample will be taken for approximately every 2,000 tons as the soil is collected to determine suitability as growth medium/substitute topsoil. The soil resources will be supplemented as described in Section 2.4.3.

2.30 Operation Plan

2.3.1 General Requirements

2.3.1.1 Removing and Storing Soil Methods

The SUFCO Mine has been in operation since 1941. At the time the main facilities in East Spring Canyon were constructed, no topsoil was segregated and saved. Topsoil and other fill material was used in construction of the surface facilities pad. However, soils removed from the Link Canyon Substation No. 1 area are to be stored in the outslope of the substation pad. Additionally, the soils removed from the Link Canyon Substation No.2 area will be stored in a small stockpile adjacent to the substation pad. The mix of topsoil and subsoil will be used as substitute topsoil at the time of reclamation. Soils removed from the Link Canyon Mine Portal area will be stored in a topsoil pile located south of the disturbed portal pad area out of the floodplain (Plate 5-2F). The majority of the portal area has been previously disturbed and only thin topsoil layers exist in portions of the disturbed area. Topsoil will be carefully removed with efforts made to minimize the amount of subsoil salvaged since most of the subsoils are not suitable as substitute topsoil or growth media.

The methods described herein are followed when removing and storing soil resources that necessitate removal as a result of construction of new surface operations.

Soil salvage will take place in two lifts where possible. The first lift will include the A horizon material to be stockpiled in one location and the second lift will include the remaining B and C horizons, excluding material with a coarse fragment content of over 50 percent. The latter would be stockpiled in a third, but adjacent location. These stockpiles will be graded to gradual slopes (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.

In the Link Canyon Substation No. 1 disturbed area, the A and C horizons will be removed together from the topsoil salvage area and stored on the pad outslope as a single soil resource. A 3 inch wide non-biodegradable polyethylene underground warning tape marker flagging will be utilized on an eight foot centerline square grid pattern to mark the proximity of the original, undisturbed topsoil surface area beneath the side-cast materials to help prevent surface damage during reclamation and excavation of the side-cast topsoil. The maximum projected volume of topsoil salvage based on the soil survey depth of 20 inches and the projected topsoil salvage area of 0.08 acres is 224 cubic yards. The projected original, undisturbed topsoil surface area that will be marked with flagging tape (0.10 acres) and the projected cut Topsoil salvage area (0.08 acres) are delineated by the Cut and Fill Boundary line as shown on Plate 5-2D. The salvaged topsoil will be removed as a separate layer, segregated and placed on the south end of the pad outslope. The remaining excavated material in the deeper cuts will be used as fill material for the access road and the north end of the substation pad.

The soil to be removed at the Link Canyon Substation No. 2 will include the A horizons and a portion of the C horizon. As described in Appendix 2-6, six mapped soil units exist in the No. 2 pad area. Following is an estimated volume of soil to be salvaged and placed in the topsoil storage pile based on the area of each soil unit and average depth of salvage for each unit area. The actual total volume of soil stored may differ from the total provided below and is dependant upon conditions found during construction.

Soil Map Unit	Estimated Thickness (ave)	Mapped Area	Volume
A	24-inches	612 sf	24 CY
B	8-inches	579 sf	14 CY
C	6-inches	473 sf	9 CY
D	36-inches	600 sf (approx.)	67 CY
E	8-inches	28 sf	1 CY
F	5-inches	198 sf	3 CY
		TOTAL	118 CY

The A and C horizons will be removed together from the topsoil salvage area and stored in the pile as a single soil resource. Type D soils, the overcast from the east side of the trolley road, will be recovered prior to construction of the substation pad. All available suitable soils encountered during site construction will be salvaged and stored for final reclamation. A person qualified to make soil salvaging determinations will be on site during construction.

Six soil types and waste coal were identified by Dan Larsen (EIS) during his investigation of the soils in the Link Canyon Mine Portal disturbed area. The soil types and thicknesses of salvageable topsoil are listed below:

Soil Map Unit		Approx. Thickness	Mapped Area(approx.)	Volume
WC	Waste Coal	0 inches	250 sf	0 CY
DR	Disturbed old access road	6 inches	1300 sf	24 CY
CU	Calcic Ustochrepts	6 inches	800 sf	15 CY
TUE	Typic Ustochrepts, eroded, carbonatic	4 inches	200 sf	3 CY
TUL	Typic Ustochrepts, light colored	6 inches	20 sf	1 CY
VS	Very stoney and bouldery area	0 inches	100 sf	0 CY
RP	Riparian sites	6 inches	2000	37 CY
				80 CY

All available suitable soils encountered during portal site construction will be salvaged and stored for final reclamation (Plate 5-2F). A person qualified to make soil salvaging determinations will be on site during construction. The volume of topsoil salvaged was 38 cubic yards. The location of the topsoil pile is shown on the revised As-Built Plate 5-2F. The remaining excavated material will be used as fill material for the access road and the portal pad. A tracked vehicle, such as a trackhoe, will be used to remove the initial topsoil layers from the access road and pad area. As the site is constructed and space becomes available, a rubber-tired vehicle, such as a front end loader or backhoe, may be used to remove soils. During the topsoil removal process, a moisture level of at least 15% will be maintained in the soils to reduce dust and loss of the resource. Maintaining soil moisture may be accomplished using a water truck equipped with pumps and hoses and personnel assigned to spraying the dry soils prior to and during salvage operations.

The sewer leach field for the mine site buildings will be expanded and two new water holding tanks will be buried in place at the existing pump house in the Fall of 2001. In both cases, the soils at these two locations have been disturbed in the past. A field investigation conducted of the site in October 2001 found that top soil was not present at either site. Following is a description of the plan to salvage and replace the subsoils at the two locations.

The additional leach field laterals will require a disturbance of approximately 60 by 70 feet, or 4200 square feet. The soils in the planned disturbed area no longer had a topsoil layer. The upper most layer of soil was approximately 1- to 3-inches thick and consisted of a grayish brown loose, sandy and silty loam with some fine to coarse gravels. It appeared to be a remnant of a C horizon prior to surface disturbance. The soils had been left undisturbed long enough for some vegetation to grow and vegetative litter, in small concentrations, was present. Underlying the C horizon remnant was a C2 horizon that consisted of brown very gravelly sand. The gravel was fine to coarse and large sandstone cobbles were present. The soils were dry.

It is anticipated that the upper 1- to 3-inches of the soils will be removed from the area prior to disturbance. During soil removal operation, a field supervisor will be at the location to monitor the removal of the soils. The total depth of soil removal will be based upon the color change between the upper most and underlying layer and the use of a tape measure. For calculation purposes, the upper layer of soils was assumed to average 2-inches. Therefore, the total material removed prior to excavating the lateral trenches is:

4200 sq ft X 0.17 ft = 714 cubic feet or approximately 26 cubic yards.

The 26 yards of salvaged soils will be removed and placed temporarily on the top of the existing leach field immediately adjacent to and southeast of the new lateral locations. The remaining material, C2 horizon, will be excavated from the trenches and temporarily stored adjacent to the excavation but not mixed with the 26 cubic yards of salvaged soil. After the laterals are placed, the excavated C2 material will be replaced in the trench and any remaining material will be evenly spread over the disturbed trench area. The salvaged 26 cubic yards of soils will then be spread over the disturbed area. The surface will be left in a roughened state to reduce erosion. Reseeding of the area will take place as soon as practical.

The location of the new water tanks was near the bottom of the drainage. The soils in the immediate area of the two new water tanks consisted of at least four feet of sand with lenses of very fine silt. The upper 0- to 3-inches of the sand occasionally contained some vegetative material. However, this material did not significantly differ from the underlying four feet of sand. The soil also contained occasional lenses of fine gravel. It is anticipated that the coarseness of the material would increase with depth (i.e., a coarsening downward sequence often associated with high energy stream deposits).

No soil salvage is anticipated at this location since previous disturbance has essentially removed the uppermost layers of salvage value. During construction of the pits in which the new tanks will be placed, the sand removed from the pits will be placed to one side, the tanks put in place, and the pits backfilled with the removed sand. It is anticipated the sand removed from the pits will be used as bedding material. The remaining sand will be spread over the disturbed area and also used to supplement the existing surface runoff control berms already in the tank area.

A 300,000 gallon fire water tank will be constructed in the fall of 2001 north of the mine site substation which is located on the hill side above the portals and mine buildings. Construction of the tank will require the removal of soils and weathered bedrock. The soils in the area consist of soils Type X as described in Section 2.2.2.3 of this chapter. A profile of the exposed soil in a cut adjacent to the substation and within the tank area was measured and described. The identified A 1 horizon extended from 1.5- to 7.5-inches below ground surface. The area had an average of 1.5 inches of vegetative litter from sage brush, pinyon, and junipers. The AC horizon extended from a depth of 7.5- to 12.0-inches below the surface. The Cca horizon extended from a depth of 12.0-inches to approximately 42-inches. Underlying this unit was weathered bedrock of sandstone and siltstone. A copy of the field log data sheet is included in Appendix 2-2.

Salvaged soil volumes for the disturbance related to construction of the fire water tank are based on the measured thicknesses described above of the A 1 (topsoil) horizon, underlying AC and Cca horizons (subsoils), and the cut and fill calculations provided on Figure 5-OE of Chapter 5 of this permit. The A1 horizon in the area appeared to have a maximum thickness of 6-inches. As described previously in this section, where the topsoil is less than 6-inches thick, a lift of 6-inches of topsoil and subsoil will be taken and stockpiled as topsoil. The removal of the first 6-inches of soil will be observed and measured in the field by the site construction supervisor or a trained representative. The total area where soil salvage will be performed is approximately 0.07 acres (3,049 sq ft). Based on this area, the following volumes of salvaged soils were estimated:

A1 or topsoil - maximum thickness 0.5 ft.

0.5 ft X 3,049 sq ft = 1,525 cu ft (~56 cu yds)

The volume of salvagable topsoil varied from the volume originally calculated due to large sandstone boulders present in the cut area and reduced the salvable topsoil significantly, from the estimate ~56 cu yds to 8.2 cu yds.

AC and Cca horizon - average thickness of approximately 3 ft

3 ft X 3,049 sq ft = 9,147 cu ft (~339 cu yds)*

The topsoil will be removed first and transported for storage at the waste rock storage site. It will be signed and stored separately from other piles located at the site. The subsoils will be removed to a depth of 42-inches or to the boundary with the weathered bedrock. Approximately 109 cu yds of subsoil and weathered bedrock will be used as fill material at the water tank site. The remaining subsoils will be transported to the waste rock site and stored with the subsoils removed previously from the minesite. Storage of the topsoil and subsoil piles will be done in accordance with Section 2.3.1.4 of this M&RP.

The topsoil removed from construction of the overflow pond and overflow pond access road will be stockpiled on a stable surface southwest of the overflow pond, see Plate 7-4A. According to Plate 2-1 the overflow pond site consists of type T soil. The A horizon is 0 to 2 inches in depth and the B horizon is 2-12 inches in depth. The topsoil stockpile will be segregated between A and B horizons. Much of the site of the overflow pond is on steep hill sides where topsoil is less then 6 inches deep. Assuming an average of 12 inches of removal the following quantities have been calculated:

0.167 ft X 49,950 sq ft = 8,342 cu ft (~309 cy) horizon A

0.833 ft X 49,950 sq ft = 41,608 cu ft (~1,541 cy) horizon B

Total 309 cy + 1,541 cy = 1,850 cy

A site specific soil survey will be completed for the Overflow Pond prior to disturbance and this information will be utilized in determining topsoil salvage depth. During topsoil removal observations and measurements in the field will be conducted by the site construction supervisor or a trained representative. Actual volume of topsoil removed and stockpiled for the Overflow Pond was 1,488 cubic yards.

During the topsoil removal operation for the temporary access road for the construction of the bypass culvert portion of the overflow pond, the total depth of soil removal will be based upon the color change between the upper most and underlying layer and the use of a tape measure. For calculation purposes, the upper layer of soils was assumed to average 12-inches. Therefore, the total material removed prior to excavating the bypass culvert trench is:

13000 sq ft X 1.0 ft = 13000 cubic feet or approximately 482 cubic yards.

The 482 yards of salvaged soils will be removed and placed adjacent to the new bypass culvert trench location. The remaining material, C2 horizon, will be excavated from the trench and temporarily stored adjacent to the excavation but not mixed with the 482 cubic yards of salvaged soil. After the culvert is placed, the excavated C2 material will be replaced in the trench and any remaining material will be evenly spread over the disturbed trench area. The salvaged 482 cubic yards of soils will then be spread over the disturbed area. The surface will be left in a roughened state to reduce erosion. Reseeding of the area followed the completion of construction in 2010.

2.3.1.2 Suitability of Topsoil Substitutes/Supplements

See Section 2.3.3.2

2.3.1.3 Testing of Topsoil Handling and Reclamation Procedures Regarding Revegetation

The Applicant will exercise care to guard against erosion during and after application of topsoil and will employ the necessary measures to ensure the stability of topsoil on graded slopes. Erosion control measures will include surface roughing and erosion mat placement on slope areas thought to be unstable. The Applicant will fill, regrade, or otherwise stabilize any rills or gullies deeper than nine (9) inches which form in areas which have been regraded and topsoiled. The areas adjacent to any rills or gullies which have been filled, regraded or otherwise stabilized, will be reseeded or stabilized accordingly.

Methods used to evaluate success of revegetation and stabilization appear in page 37 of Appendix 2-2. Erosion monitor pins will be placed on the slopes at the time of reseeding. Locations of the erosion pins will be obtained via a random number generator. The pin locations will be surveyed and revegetation analyses conducted annually following completion of reseeding, until the release of the bond.

2.3.1.4 Construction, Modification, Use, and Maintenance of Topsoil Storage Piles

The topsoil storage piles (Plate 2-1) at the SUFCO Mine in East Spring Canyon area consist of small amounts of topsoil, from the substation pad (27 cubic yards) and the area where the sediment pond (1,200 cubic yards) was constructed. The topsoil materials were segregated and stockpiled. The stockpiled materials were selectively placed in small area exemption areas within the permit area on stable surface areas below the sediment pond (0.105 acres) and on the south end of the substation pad (0.02 acre). The topsoil small area exemption stockpiles are isolated with no means of access from the main surface area to protect the topsoil from contaminants and unnecessary compaction that would interfere with vegetation. A topsoil storage sign was installed at the base of each stockpile. The stockpiles were protected from wind and water erosion by being revegetated with a quick growing vegetative cover (proposed seed mix minus the shrubs and trees) and by installing silt fence below the stockpiles to help trap sediment coming off the stockpile. This topsoil will not be moved or disturbed until required for redistribution during final reclamation.

Topsoil from the Overflow Pond will be placed in a topsoil pile located southwest of the overflow pond area. This storage area will be protected with berms and/or silt fences, a three-strand barbwire fence, and revegetated with a quick growing vegetative cover (standard seed mix in section 3.4.1.2 minus the shrubs and trees) to control erosion. The surface of the topsoil pile will be pitted to reduce runoff and erosion. This soil will not be moved or disturbed until it is required for redistribution during final reclamation. A figure of the surveyed topsoil stockpile and estimated quantity of soil stored in the pile is included in Appendix 2-2. Plate 5-2B shows the as-built features associated with the overflow pond.

Topsoil from the Link Canyon Substation No. 1 will be placed and stored on the outslope of the pad. This storage area will be protected with berms and/or silt fences, a three-strand barbwire fence, and revegetated to control erosion. This soil will not be moved or disturbed until it is required for redistribution during final reclamation.

Soil from the Link Canyon Substation No. 2 will be placed in a soil stock pile located at the south end of the pad area. The storage area will be protected with berms and/or silt fences, a three strand barbwire fence, and revegetated to control erosion. This soil will not be moved or disturbed until it is required for redistribution during final reclamation.

Soil from the Link Canyon Mine Portal area will be placed in a topsoil pile located south of the disturbed portal pad area out of the floodplain (Plate 5-2F). The storage area will be protected by installing a topsoil storage sign at the base of the pile, berms and/or silt fences, a three strand barbwire fence, and protected from wind and water erosion by surface pitting the stockpile to retain moisture and reduce erosion and by being revegetated with a quick growing vegetative cover (standard seed mix in section 3.4.1.2 minus the shrubs and trees) to control erosion. This soil will not be moved or disturbed until it is required for redistribution during final reclamation. The surface of the topsoil pile will be pitted to reduce runoff and erosion. Vegetation removed during site construction, such as sage brush and other woody plants, will be placed on top of the pile.

Excess subsoil associated with construction of a run of mine coal stockpile and the West Lease portal tunnel development is stored at SUFCO Mine's waste rock disposal site. At the mine site the substation binwall has approximately 2,160 cubic yards of subsoil material and 5,300 cubic yards of road base, with the additional 11,747 cubic yards of subsoil material (Soil Nail Wall/West Lease/run of mine stockpile) being stored at the waste rock site there is a total of 19,207 cubic yards (approximate) that will be available for use as subsoil material during final reclamation of the mine site facilities. Reference Appendix 2-3 for the analyses of the subsoil being stored at the waste rock site to be used during reclamation of the mine site.

Approximately 487 cyds of subsoil was removed during the stabilization construction of a soil nail wall located behind the Warehouse Annex Building.

Immediately adjacent to the subsoil pile at the waste rock site is stored 756.3 cubic yards of topsoil collected from beneath the footprint of the subsoil pile. This total represents the removal of approximately 12" of topsoil prior to placement of the subsoil. Section 3.1.6 of Volume 3 of this M&RP contains more information pertaining to the soils stored at the waste rock disposal site.

2.3.2 Topsoil and Subsoil Removal

2.3.2.1 Topsoil Removal and Segregation

All topsoil thicker than 6 inches will be removed as a separate layer from the subsoil, segregated, and stockpiled separately. Topsoil less than 6 inches thick will be removed according to Section 2.3.2.3. However, in the areas of the Link Canyon Substation Nos. 1 and 2 pads, all soil will be removed and stored in one area as a single soil resource. At substation pad No. 1, the maximum projected volume of topsoil salvage based on the soil survey depth of 20 inches and the projected topsoil salvage area of 0.08 acres is 224 cubic yards. The salvaged topsoil will be removed as a separate layer, segregated and placed on the south end of the pad outslope. The remaining excavated material in the deeper cuts will be used as fill material for the access road and the north end of the substation pad. At substation No. 2, the volume of soil projected to be removed is 118 CY.

2.3.2.2 Poor Topsoil

Topsoil that is of an insufficient quantity, or of poor quality (for sustaining vegetation) will be removed as a separate layer and segregated. Such operations will be done with approval of the UDOGM, and in compliance with R645-301-233.100 (Section 2.3.3.1).

2.3.2.3 Thin Topsoil

Topsoil to be removed that is less than 6 inches thick will be removed with the immediately underlying unconsolidated materials (up to a total of 6 inches). This material mixture will be treated as topsoil and stockpiled together without any horizon segregation.

2.3.2.4 Minor Disturbances Not Requiring Topsoil Removal

Small Structures. Topsoil will not be removed prior to construction resulting in only minor disturbances as described in R645-301-232.400. Such construction activity includes work on small structures such as power poles, signs, fence lines, and other small structures which do not significantly disturb the site.

Vegetation. SUFCO Mine will not remove topsoil for minor disturbances where such activity will not destroy vegetation or cause erosion.

2.3.2.5 Subsoil Segregation

Due to the poor quality of the subsoil, the B and C soil horizons will not be individually segregated and stockpiled. The topsoil will be segregated and stockpiled separately from the subsoil (B & C horizons) except in the area of the Link Canyon Substations Nos. 1 and 2, and Link Canyon Mine Portal. These soils will be salvaged as specified in Section 2.3.2.1

2.3.2.6 Timing

Where possible, soil removal will take place after all vegetation has been removed that could interfere with soil salvage. Surface disturbance activities will take place after the soil has been removed.

2.3.2.7 Topsoil and Subsoil Removal Under Adverse Conditions

In areas of surface disturbance, topsoil and subsoil will be each removed separately and segregated, except where natural conditions render operations hazardous.

Conventional Machines. In localities where steep grades, adverse terrains, severe rockiness, limited depth of soils, or other adverse conditions exist that render soil removal and segregation activities using conventional machines hazardous, soils will not be salvaged and stockpiled.

Substitute Topsoil. Importing of substitute topsoil is not expected to be required. The applicant will evaluate importation of topsoil with the regulatory authority if deemed necessary based upon revegetation success.

2.3.3 Topsoil Substitutes and Supplements

2.3.3.1 Overburden Materials Supplementing and/or Replacing Topsoil

Selected overburden materials may be used as a supplement to topsoil during reclamation operations. If overburden materials are used, the operator commits to demonstrating, to the UDOGM prior to topsoil emplacement, that the resultant soil is equal to or more suitable than the original soil in supporting revegetation efforts.

2.3.3.2 Suitability of Topsoil Substitutes and Supplements

At the time (1941) the Convulsion Canyon operations began and surface facilities were constructed, no topsoil was segregated and saved. Topsoil and other fill material was used in construction of the surface facilities pad. This material will be excavated and used as a topsoil substitute after recontouring of the site during reclamation. The total quantity of this topsoil substitute required for a 6-inch soil layer will come from within the present mine facility pad fill and from slopes at the mine which are restored during the active life of the mine. A random composite sample will be taken for every 2000 tons as the topsoil is collected. Topsoil will be collected into a pile for storage during the recontouring process and spread over the disturbed area prior to preparation for seeding.

2.3.3.3 Physical and Chemical Analyses

Physical and chemical analyses of the soil material will be conducted during collection operations to determine if/what supplemental fertilizer is needed. The material has already been tested where it is exposed and a report describing its vegetation potential appears in Appendix 2-3.

The applicant will utilize the proposed topsoil subsequent to approval by the regulatory authorities.

Certification of Reclamation Topsoil Suitability. The suitability of the substitute topsoil shall be certified by an approved laboratory in accordance with at least one of the following: Soil Conservation Service (SCS) published data, SCS technical guides, state agricultural agency, Tennessee Valley Authority, BLM - USFS published data, physical and chemical analyses results, field-site trials, and greenhouse tests.

2.3.3.4 Testing of Substitute Topsoil

Only the substitute topsoil used in lieu of, or in conjunction with, on-site overburden and topsoil will be tested as described in Section 2.3.3.3.

2.3.4 Topsoil Storage

2.3.4.1 Topsoil Stockpiling

Topsoil removed will be stockpiled for later use in reclamation operations when it is impractical to promptly redistribute the topsoil on regraded areas.

Presently, the topsoil storage piles at the SUFCO Mine are of the small amounts of topsoil removed from the substation and sediment pond areas (Section 2.3.1.4).

2.3.4.2 Stockpiled Topsoil

Stable Stockpile Site. Stockpiled materials will be placed on a stable site within the permit area. The topsoil pile containing the topsoil removed from the sediment pond site was stockpiled in a small area exemption pile on a stable surface area (0.105 acres) below the sediment pond (Section 2.3.1.4). Topsoil removed for the construction of the overflow pond is stockpiled southwest of the overflow pond, see Plate 7-4A, in a small area exemption pile on a stable surface area (0.141 acres) The topsoil pile containing the soil removed from the substation area (0.02 acres) is located in a small area exemption pile on the south side of the substation. Topsoil removed from the Link Canyon Substation No. 1 will be located on the outslope below the pad as shown on Plate 5-2D. Topsoil removed from the Link Canyon Substation No. 2 will be stored in the soil stockpile as shown on Plate 5-2E. Topsoil removed from the Link Canyon Mine Portal area will be stored in the soil stockpile as shown on Plate 5-2F.

Protection from Contaminants and Compaction. Stockpiled topsoil shall be protected from contaminants and unnecessary compaction. To protect the topsoil from contaminants and unnecessary compaction that could interfere with vegetation, the sediment pond topsoil and the substation stockpiles are isolated with no means of access from the main surface area (Section 2.3.1.4). A topsoil storage sign was installed at the base of both stockpiles and will be placed on the Link Canyon Substations Nos. 1 and 2 and Link Canyon Mine Portal storage areas.

Wind and Water Erosion Protection. All topsoil stockpiles will be protected from wind and water erosion by prompt establishment and maintenance of a vegetative cover (standard seed mix in section 3.4.1.2 minus the shrubs and trees). The sediment pond and substation topsoil stockpiles are protected from wind and water erosion by the establishment of a protective vegetative cover. The Link Canyon Portal topsoil pile will be protected by adding vegetative material removed during site construction. Grasses native to the area will be planted either through seeding or by obtaining and planting plugs from nearby undisturbed sites. A silt fence was installed below the stockpiles to help trap sediment runoff from the stockpiles.

Topsoil Redistribution. All stockpiled topsoil will not be moved until redistributed during reclamation operations unless approved by the UDOGM.

2.3.4.3 Topsoil Stockpile Relocation

Stockpiled topsoil in jeopardy of being detrimentally affected in terms of its quantity and quality by mine operations may be temporarily redistributed after approval from the UDOGM.

Host Site. Topsoil relocation may occur provided that such action does not permanently adversely affect topsoil of the host site.

Topsoil Suitability. Topsoil relocation may occur provided the topsoil is retained in a condition more suitable for redistribution than if stockpiled.

2.40 Reclamation Plan

2.4.1 General Requirements

Topsoil redistribution, amendments, and stabilization are discussed in Sections 2.4.2, 2.4.3, and 2.4.4, respectively.

2.4.2 Soil Redistribution

2.4.2.1 Soil Redistribution Practices

In addition to the redistribution practices discussed herein, the following action will be taken. Within the disturbed areas the contaminated surface soil layer will be removed and stored during the final reclamation process. The contaminating gravels, crushed stone, and other contaminates will be buried along with the structure foundations.

Soil Thickness. Topsoil will be distributed on all areas with slopes less than 1h:l.5v that are to be reclaimed. Topsoil redistribution procedures will ensure an approximate uniform thickness of six inches. During this time period, the topsoil will be allowed to settle and attain equilibrium with its natural environment. This procedure will be followed for all areas in which facilities such as road beds, mine pads, and building sites are to be abandoned.

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, only track-mounted equipment (example bulldozer) will be used to spread the topsoil. The topsoil will be disced 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.

In the 300,000 gallon fire water tank area, the concrete foundation of the water tank will be broken up and placed against the base of the cutslope. The fill material used to create the foundation pad will be used first to backfill the tank area. The remainder of the fill necessary for reclamation will be obtained from the subsoil stock pile at the waste rock site. Finally, the topsoils will be returned to the site for distribution. The thickness of the redistributed topsoil should roughly equal six inches, the thickness originally removed.

Erosion. Procedures will be exercised to ensure the stability of topsoil on graded slopes to guard against erosion during and after topsoil application. Erosion control measures will include surface roughing, pitting, deep gouging, and/or placement of organic matting on slope areas thought to be unstable.

2.4.2.2 Regrading

Since the mine is over 55 years old, there are no private or public topographic maps which can be used to accurately determine the original geometric configuration of the canyon. Prior to topsoil redistribution, the disturbed area will be regraded to agree with final reclamation topography (Chapter 5 and Plate 5-3).

The postmining topography was designed by Sergent, Hauskins & Beckwith's (SH&B) (Appendix 2-4). The cut and fill quantities are 74,734 and 71,173 yards, respectively (Appendix 2-5). These values supersede those presented in Appendix 2-4.

On slopes less than 1.5h:1v, regraded land will be scarified by a ripper-equipped tractor or with other suitable equipment. The surface will be ripped to a suitable depth to reduce surface compaction, provide a roughened surface to assure topsoil adherence, and promote root penetration.

2.4.2.3 Topsoil Redistribution on Impoundments and Roads

This regulation does not apply as the sedimentation pond and dam will be dismantled and reclaimed with the other surface disturbed areas. Similarly, reclamation of abandoned roads will also follow the same technique as for other disturbed areas.

2.4.3 Soil Nutrients and Amendments

Soil nutrients and amendments will be applied to the redistributed soil as necessary, to establish the vegetative cover. Soils will be analyzed prior to redistributing, following the Division's Guidelines for Management of Topsoil and Overburden, to determine what fertilizers and amendments will promote successful revegetation and the appropriate application rates.

2.4.4 Soil Stabilization

2.4.4.1 Protection and Stabilization of Surface Areas

All reclaimed areas will be stabilized to control erosion by application of mulch and regrading of rills and gullies.

The Link Canyon Substations Nos. 1 and 2 and Portal area reclaimed pads, access roads, and affected slopes will be pitted or deep gouged and have the large rocks and boulders and slash previously removed spread out over the surface to help increase soil stability and will be fenced to prevent damage from cattle grazing during reclamation.

2.4.4.2 Mulch Application

Mulch will be applied to all areas that have been regraded and covered with soil to stabilize the topsoil. For further discussion of revegetation practices to be utilized see Chapter 3.

2.4.4.3 Rills and Gullies

Postmining Land Use and Revegetation. Rills and gullies that disrupt the postmining land use or reestablishment of vegetative cover will be regraded, the topsoil replaced, and reseeded.

Water Quality. Rills and gullies that contribute to the degradation of stream quality will be regraded, receive new topsoil, and be revegetated.

2.50 Performance Standards

2.5.1 Topsoil, Subsoil, and Topsoil Supplements Management

All topsoil, subsoil, and topsoil supplements shall be managed as outlined in Sections 2.30 and 2.40.

2.5.2 Stockpiled Topsoil and Subsoil

All stockpiled topsoil and subsoil will be managed according to plans outlined in Sections 2.30 and 2.40.

REFERENCES:

Johnson, Wm. M., 1975, Soil Taxonomy, A Basic System of Soil Classification For Making and Interpreting Soil Surveys, Supt. of Doc. S.C.S., Washington, D.C.

U.S. Department of the Interior, Final Supplemental Impact Statement for Leasing and Underground Mining of the Greens Hollow Federal Coal Lease Tract UTU-84102, Sanpete and Sevier Counties, Utah, February 2015

THE ENTIRE TEXT FOR EACH CHAPTER IS INCLUDED IN THIS SUBMITTAL FOR EASE OF REVIEW.

ONCE APPROVED ONLY PAGES WITH CHANGES WILL BE SUBMITTED.

CHAPTER 3

BIOLOGY

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CHAPTER 3
BIOLOGY

3.10 Introduction

This chapter presents a description of the biological resources found on the SUFCO Mine site. The mine is located approximately 30 miles east of Salina, Utah.

Several consultant reports will be referenced in this M&RP, so for simplicity purposes the report titles will appear as the following abbreviations:

EPS - Report of Studies of Vegetation and Soils for SUFCO Mine - 1980 (Appendix 2-2)

INV - Report of 1983 Field Investigations - 1983 (Appendix 3-1)

AQU - Aquatic Resource Inventory of Southern Utah Fuel Company Permit Area - 1980 (Appendix 3-2)

WIL - Wildlife Assessment of the Southern Utah Fuel Company Mining Property and Adjacent Areas - 1980 (Appendix 3-3)

RAP - Raptor and General Avifauna Studies - 1980 (Appendix 3-4)

FSW - Fauna of Southeastern Utah and Life Requisites Regarding their Ecosystems - 1990 (Appendix 3-5)

VWP - Vegetation and Wildlife of the Pines Tract Project - 1999 (Appendix 3-9).

Reports in the appendices are provided only to present Baseline Data in support of the Mining and Reclamation Plan. Proposals or recommendation presented by consultants were duly considered in preparation of the Mining and Reclamation Plan chapter commitments but not all of them were determined to be appropriate or advisable.

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

3.1.1 Vegetative, Fish and Wildlife Resources

Vegetative, fish and wildlife resource conditions in and adjacent to the SUFCO Mine are discussed in Section 3.20.

3.1.2 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 3.30 and 3.40 of this application.

3.1.3 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 3.40.

3.20 Environmental Description

3.2.1 Vegetation Information

This section contains the environmental descriptions for the vegetation for the permit and adjacent areas.

3.2.1.1 Plant Communities Within the Proposed Permit Area

"Vegetation changes from one landform to another. On the benches landform, there is a combination of sagebrush-grass community and ponderosa pine stands. Intermixed are patches of low quality Quaking Aspen, Mountain Mahogany, and Manzanita brush. Ground cover is composed of several native grasses, forbs, and low brush species. Density is generally good.

The steep slopes and scarp faces landform is sparsely vegetated. Pinyon, Juniper, and Mountain Mahogany are scattered over the landform. The site is very harsh and ground vegetation is limited to light quantities of native grasses and forbs in cracks and shelves where soil can accumulate. Composition includes a few drought resistant grasses, annual forbs, Mountain Mahogany and other brush.

Narrow stringers in canyon bottoms are the most productive in the area. Vegetation is primarily native grass, low brush and forbs growing together to form a heavy sod. Brush types include willow, rose, rabbit brush, sand brush and others. Carex grows in some of the wetter spots. Only an occasional tree occurs in the bottoms.

The rolling hills landform is covered by an occasional small patch of trees which include Ponderosa pine, Douglas-fir, Alpine-fir, Spruce and Aspen. More common are brush species including oak, snowberry, and sagebrush. Grasses and forbs are very sparse and include several native species." (Blumer, 1979)

The plant communities identified within the proposed permit area are (see Plate 3-1):

Sagebrush-grass

Grass-black sagebrush

Mountain Brush (oak, serviceberry, mountain mahogany, etc.)

Aspen

Aspen-oak

Aspen-Douglas fir-limber pine

Mountain mahogany-oak-ponderosa pine

Douglas fir-spruce-limber pine

Pinyon-juniper-mountain mahogany

Limber pine

Ponderosa pine-mountain mahogany-manzanita

Pinyon-juniper-Douglas fir

Wiregrass-foxtail-haplopappus

Douglas fir-spruce-limber pine-aspen

Limber pine-mountain mahogany-serviceberry

Mountain mahogany

Pinyon-juniper

Douglas fir & other

Riparian

Ponderosa pine-douglas fir-aspen-serviceberry

Grassland-perennial forbs

Sagebrush

Mountain brush

Conifer timber

Mixed

Barren ground

Aspen-deciduous forest

Additional plant communities are designated on Plate 3-1.

Field sampling of these plant communities was initially done in July of 1983 and the findings were documented in the INV report. A Level II riparian inventory has been conducted along portions of East Fork of Box Canyon (USDA-USFS, 1993). The plant communities and reference areas are outlined on Plate 3-1. In 1999, another vegetation (and wildlife) report (VWP) was prepared for the proposed mine expansion called the Pines Tract Project. Vegetation communities were described and shown on a map included in that document, most of which are also listed in the plant communities shown above. The vegetation types in the SITLA Muddy Tract were identified by Cirrus and reported in EIS documents for the entire BLM and SITLA Muddy Tract. The vegetation types in the SITLA Muddy Tract are illustrated on Plate 3-1. This plate will be updated in the appropriate season of 2006 to more clearly indicate types and extent of vegetation in the SITLA Muddy Tract. As of October 2005, the available Forest Service information used to create the map is essentially correct but Sufco has agreed the vegetation boundaries and descriptions can be further refined. The work to be performed in 2006 will include the evaluation of available aerial photos of the area by a qualified person who then will create an updated vegetation map of the tract. The updated version of the plate will be submitted to the Division before the end of 2006.

Greens Hollow

The following is a listing of the approximate coverage of habitat vegetation. Mahogany and mountain brush constitutes the most abundant habitat, covering 27.4 percent of the tract and associated extended analysis area. Sagebrush covers 23.3 percent, aspen and aspen-mixed conifer 17.2 percent, grassland/forbland 11.7 percent, ponderosa pine 5.3 percent , pinyon-juniper 2.9, Rock outcrops/barren 2.1 percent and mixed conifer 1.1 percent. Limber and or/bristlecone pine were in the extended analysis area only covering 1 percent.

A description of the potential impacts of mining on vegetation is included in Section 3.3.3.3 of this permit.

3.2.1.2 Land Productivity Prior to Mining

The land productivity of the mine area was not measured in 1941 when mining began. However, Appendix 2-2 contains a consultant study (EPS, pgs. 45 - 78) compiled in 1980, which states total cover, production pounds per acre and species within the permit area. Additional information was presented in INV Report, August 12, 1983 (Appendix 3-1).

3.2.2 Fish and Wildlife Information

A summary of the fish and wildlife resource information for the permit and adjacent areas is contained in Sections 3.2.2.1 through 3.2.2.3. As mentioned above, a wildlife report was included with a vegetation report in 1999 (VWP) for the proposed mine expansion called the Pines Tract Project. Fish and wildlife resources in the SITLA Muddy tract are as described in Sections 3.2.2.1 through 3.2.2.3 and in the "Muddy Creek Summary Report - Wildlife" prepared by Cirrus and included as Appendix 3-11. Fish and wildlife resources within the West Coal Lease Modifications are summarized in Appendix 3-13. A description of the potential impacts and mitigation of impacts of mining on fish and wildlife is included in Section 3.3.3.3 of this permit.

Due to either their small size, intermittent flows, poor habitat or water quality, the surface waters in the lease area are not of game fish quality. The low importance of the streams as a fishery resource, has categorized them as being of little value for extensive study. An inventory of the aquatic resources is located in Appendix 3-2. Aquatic resources of the Pines Tract Project are briefly described in the wildlife section of Appendix 3-9. Aquatic resources within the Muddy Tract are summarized in Appendix 3-11. Aquatic resources within the West Coal Lease Modifications are summarized in Appendix 3-13. Aquatic resources for the Greens Hollow Tract are summarized in Appendix 3-15.

3.2.2.1 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.

This assessment of wildlife resources has been compiled pursuant to guidelines issued by the State of Utah Division of Oil, Gas and Mining (UDOGM). Appendices 3-3, 3-4, 3-5, and 3-9 contain wildlife studies related to their resources in the mine area.

3.2.2.2 Site-specific Resource Information

The following information was summarized from the WIL, RAP, AQU, and VWP Reports. Additional information is available in Appendix 3-2 through 3-5, and 3-9.

Reptiles and Amphibians

Increasing elevation rapidly reduces the number and kind of reptiles and amphibians. Furthermore, in Utah the effects of the more northern latitude reduces the number of reptiles in much the same way as does the increase in elevation.

These geographical and associated climatic factors have eliminated most desert species, leaving species that are adapted either to mountain habitats or montane type habitats developed in the more northern areas.

Literature pertaining to the amphibians and reptiles is extensive; but, much of it refers to species occurring in the desert areas and has only limited reference to forms inhabiting Utah mountains.

Based on the extensive literature review and limited field work it was determined that potentially 8 species of amphibians (Appendix 3-5) inhabit the area of concern which provides substantial value habitat . All amphibians are legally protected, but since the species listed are all widespread throughout the mountains of Utah, none are treated as high-interest species. It is doubtful that the proposed action would seriously impact populations, but localized individuals may be involve in habitat destruction due to subsidence. An exception to this would be if subsidence interrupted underground aquifers and caused drying of present wet habitats essential to reproduction.

Based on the literature search and limited field work, it was determined that potentially 14 species of reptiles (Appendix 3-5) occupy the mine land area, a substantial value habitat for all species. All reptiles are legally protected but since the species listed are all widespread throughout montane habitats in Utah, none are treated as high-interest species and, therefore, are not individually discussed. It is doubtful that the proposed action would seriously impact populations.

Information about reptiles and amphibians specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). Information about reptiles and amphibians specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). Information about reptiles and amphibians specific to the West Coal Lease Modifications are summarized in Appendix 3-13.

Wetlands and riparian areas exist within the permit area and have been estimated to represent less than one percent of the total acreage within Pines Tract Project Area and SITLA Muddy Tract. These areas are supported by streams, springs, and seeps located throughout the drainages. Studies in the semi-arid West comparing riparian areas with adjacent uplands showed that riparian zones support up to 400 percent more plant biomass, up to 200 percent more species, and contribute to large increases in density and species richness for birds when compared to upland areas.

Between 69% to 92% of all amphibian occur in wetland ecosystems. The scaleless, permeable amphibian skin requires constant moisture to retain body fluids. Both water quantity and quality parameters are of importance to the survival of individual amphibians and ultimately populations of the species.

Reptiles are not nearly as dependent on wetlands since their scaly covering provide resistance to desiccation. Riparian areas are heavily utilized (50% to 72% of all species) for the available drinking water, prey, and vegetative resource (cover). The moist soil characteristic of riparian zones also provide preferred nesting habitat for many reptiles.

The riparian areas for the Pines tract Project Area, Link Canyon, and SITLA Muddy Tract are shown on Plate 3-1. A survey for amphibians and mollusks was conducted in the Link Canyon Portal area in June of 2002. No amphibians or mollusks where found in the portal area nor where any protected or sensitive species found in the area. A copy of a report of the investigation is contained in Appendix 2-9.

Raptors

Only one nest, that of a Cooper's Hawk, was found in 1980 (Appendix 3-4). The one Cooper's Hawk nest found was in an area seemingly less favorable than surrounding canyons. Quitchupah Canyon appeared to be prime habitat, but no nests were found.
Golden Eagles were seen on nearly every survey day during the 1980 survey by Clayton White of Brigham Young University (Appendix 3-4). The presence of two adults accompanied by a juvenile suggest their nearby breeding, however no nests were located.

Appendix 3-4, Table 1 contains a list and the number of sightings for the birds inventoried during the 1980 raptor survey.

A raptor survey conducted April 14, 1987, located three Golden Eagle nests (Appendix 3-4). Two of the nests were tended and contained greenery, the third had an adult eagle incubating eggs.

In October of 1988 an environmental assessment of the Quitchupah Lease area was performed by personnel from the Forest Service and Bureau of Land Management. During the assessment 6 Golden Eagle nests were located.

The SUFCO Mine portions of the annual raptor surveys conducted by UDWR and others are located in Appendix 3-4 in the Sufco Mine MRP Confidential file. Refer to Section 3.3.3.3 for commitments and other raptor survey information. ~~Future annual raptor surveys will be submitted each year in the annual report to the Division.~~

~~Most raptor nest locations are located outside the current planned mining subsidence areas. Any raptor nest that has a potential to be disturbed by subsidence will be evaluated with DWR and FWS. An appropriate plan of action will be developed on a case by case basis.~~

The Prairie Falcon has also been reported by U.S. Forest Service and Bureau of Land Management personnel for the planning unit that encompasses the SUFCO Mine area.

The Quitchupah Drainage, of which Link Canyon is a tributary, was identified in the Quitchupah Creek Road DEIS (2001) as not likely to contain Mexican Spotted Owls and dedicated surveys were not necessary. However, the Manti-La Sal National Forest reported that a Mexican Spotted Owl survey of the area was being conducted as part of their Muddy Creek EIS Data Adequacy study. Results of surveys conducted in 2002 and 2003 indicated no Mexican Spotted Owls were found in the Link Canyon Portal area or the Muddy Tract area (Appendix 3-12). Additionally, Sufco does not plan to conduct construction activities during the nesting and rearing times (February 1 through August 31) of the owl.

The lack of permanently running water has an effect on raptors. Many species, such as accipiters, appear to rely on streams and the associated riparian vegetation (Hennessy, 1978).

Known raptor nests are shown on Plate 3-3, refer to Section 3.3.3.3 for additional raptor information.

Information about raptors specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). Information about raptors specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). Information about raptors specific to the West Coal Lease Modifications are summarized in Appendix 3-13. Raptor surveys conducted in the Greens Hollow Tract are located in Appendix 3-4 and a discussion of raptors and bird species from technical reports prepared by Cirrus Ecological Solutions, LC is located in Appendix 3-15.

Elk

The elk herd (#14) is a significant wildlife resource to the citizens of Utah and there is considerable hunting pressure. Winter and summer range is in generally good conditions, but drought is an immediate concern (Big Game Annual Report, 1991).

Although the potential area of impact is not critical to the continued existence and perpetuation of the herd, it is important to maintenance of current population levels, and portions of the entire lease area are used annually on a seasonal basis. The aspen areas of Duncan Mountain serve as calving areas for the small herd, (10-20 animals observed during the 1980 summer in that area) but based on pellet counts (WIL, Table 7) the major portion of the lease area is utilized in late fall, winter, and early spring.

In May, while there was still snow on the ground, considerable fresh elk sign (pellets and tracks) was found around the Acord Lakes. By June 5, 1980, when access was available to the other areas, elk tracks were concentrated in the ponderosa, mahogany, aspen and manzanita communities along the ridges and rims of the canyon, plus in the canyons such as Duncan's Draw and Lizonbee Springs. During the summer the elk and elk signs were sighted near the top of Duncan Mountain and at the head of the South Fork of Quitchupah. It seems that the elk in question do not always winter on the rims nor the plateau but in the lower elevation areas to the southeast. This observation was substantiated by a conversation with a local forest ranger out of Richfield. The amount of snow is probably the determinant, with the elk wintering wherever there is available forage from the rim to the low brush areas in the southeast.

The fact that elk utilize the entire area of concern during some time of the year means that all aspects and timing of the actions must be considered. However, since the SUFCO Mine has been operational since the early 1940's and since there are no plans for additional surface facilities other than ventilation portals along the cliffs, there should be little additional disturbance to the elk. The animals have already accommodated the human disturbance associated with the mining and hauling of coal.

Information about elk winter-range and migration routes specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). Information about elk winter-range and migration specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). Information about elk winter-range and migration specific to the West Coal Lease Modifications are summarized in Appendix 3-13..

Mule Deer

Mule deer on the mine area are considered part of Herd Unit 43 by the UDWR. The animals in the environs of concern utilize the entire assessment area but seasonally concentrate in and more heavily utilize specific habitat types.

During the summer the mule deer generally utilize all of the habitats near watering areas. The most heavily used communities were the sage, mountain brush and the composite of aspen, mountain mahogany, manzanita and ponderosa. This is as expected since there is considerably more browse in these communities than in the others sampled.

With the onset of fall and winter the mule deer latitudinally migrate. Initially (late fall and early winter) they concentrate on the plateau area where they intermingle with the elk but when the snow gets too deep for them to traverse they move into the low elevation sage, and pinyon juniper areas to the southwest. The wintering areas for mule deer make them susceptible to road strikes in the vicinity of the haul and access road for the SUFCO Mine and Interstate 70.

Information about mule deer winter-range and migration routes specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). Information about mule deer winter-range and migration specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). Information about mule deer winter-range and migration specific to the West Coal Lease Modifications are summarized in Appendix 3-13.

Cougar

The entire SUFCO Mine area provides substantial value, and year long habitat for cougar. The animal ranges throughout the area as evidenced by a sighting one third of the way down the slope in Quitchupah Canyon, one half mile below the confluence of South Fork, and tracks in the mud near Jack Adley's Monument, Broad Hollow, and in the dust of the road near Acord Lakes. Though animals range throughout the area, their movements are often dictated by migration patterns of their primary food source (mule deer) and human disturbance. Concern must be given to the cougars particularly when the females are accompanied by their young who are learning to hunt and survive. This is considered a sensitive period for cougars and it is best if disturbance is minimized during this time. However, this period in their life cycle is difficult to determine for cougars since they are known to reproduce year round.

Bobcat

The mine and adjacent areas provide substantial value habitats for bobcats, who were evidenced, by sightings and tracks, to occupy or use all terrestrial habitats on the entire area of potential impact. Sensitive periods would be late February when parturition occurs, May and June when young bobcats are first exploring and learning to hunt. Bobcats are not as secretive as cougar, making them less likely to avoid the high human disturbance areas and making them more vulnerable to open human harassment and illegal killing. Since this is an ongoing mining operation, pressures on bobcats should be unchanged.

Black Bear

Bear tracks were observed in Broad Hollow, but Forest Service personnel indicated to us that most of the bear sightings occurred on White Mountain. At best black bear are not abundant nor are they active year round. Sensitive periods in the life cycle of the black bear are February and March when the cubs are born and when they accompany their mother on initial foraging expeditions during early summer. Since parturition occurs within the winter den and since disturbance in the black bear habitat will be limited to subsidence, this sensitive period will be little impacted by the proposed action.

Mountain Cottontail

The entire mine area provides substantial value, and year long habitats for cottontail rabbits. The young are born between April and July which is considered a sensitive period, but the proposed actions will in all probability not seriously alter the reproductive potential of the population. Hunting pressure will likely not increase, nor will illegal kills. However, this would not matter since hunted rabbit populations are more healthy and stable than non-hunted populations. Subsidence could potentially cause death from caving burrows and disrupt reproduction for a short time.

Snowshoe Hare

The snowshoe hare is present in and dependent upon the limited spruce-fir vegetation habitat of the mine area year round. The sensitive period for reproduction is from April 1 to August 15. Subsidence will not impact the above ground dweller as it does subterranean inhabitants. Little change in snowshoe hare populations will result from the proposed actions. Hunting pressure, legal and illegal, will be the most influential activity of man upon snowshoe hares, but will be of little far reaching impact.

Fur bearers

Limited portions of the mine and adjacent areas provide substantial value habitats for a few species categorized by management agencies as fur bearers: ermine, long-tailed weasel, badger and the striped skunk. The breeding and rearing activities of these non-migratory species occurs within the area and their dens and burrow systems are important to maintenance of their populations, but it is unlikely that the proposed actions will seriously impact them for any length of time. Subsidence will be localized and new burrows will be built or old ones reconstructed after it occurs. These species are widespread and adaptable to the activities of man.

Small Mammals

Small mammals represent a significant part of the ecosystem. The majority are herbivores and are the primary source of food for higher trophic levels, particularly raptorial birds, canids and felids. The potential exists for caving burrows in and/or changing burrow continuity due to fracturing of the strata. Should this occur, it is likely that young mammals in the nest would be crushed or cut off from parental care. Although this would temporarily alter the population density and age structure, recovery would be imminent and rapid. The 1997 Bat Survey for the SUFCO Mine conducted by J. Mark Perkins & Joshua R. Peterson is included in Appendix 3-8.

Information about small mammals specific to the Pines Tract Project area is provided in the VWP report (Appendix 3-9). General information about small mammals specific to the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). General information about small mammals specific to the West Coal Lease Modifications are summarized in Appendix 3-13 and in Appendix 3-15 for the Greens Hollow Tract.

Threatened and Endangered Plant and Wildlife Species. Passage of the Endangered Species Act of 1973 (Public Law 23-20S) provided the legal basis for establishment of lists of endangered and threatened plant species. Such lists were prepared under direction of the Smithsonian

Institution, and were published subsequently in the Federal Register (40: 2782 427924, 1975; and 41: 2452 4 24572, 1976). The region under investigation was included in a report on threatened and endangered species of the Central Coal lands of Utah (Welsh 1976). An inventory of endangered wildlife species performed in 1989 by the Division of Wildlife Resources recorded no species within the proposed permit area (conversation with Pamela Hill, DWR, Cedar City, 1991). Table 3-1 provides a list of Federally listed Threatened and Endangered Species that have been identified in the Utah counties in which Sufco lies. However, this list does not necessarily indicate these species are found within the mine permit boundaries.

A survey of the literature has failed to indicate the presence of any endangered or threatened plant species in the area. This lack of critical or unique species is supported by the field surveys of the lease areas. The region was searched by walking parallel transects on a quarter-section by quarter-section basis, with each community type within each quarter-section being traversed. No endangered or threatened species were encountered in the lease area or in the adjacent areas.

There are no federally listed threatened or endangered fish species inhabiting the aquatic habitat.

A discussion about threatened, endangered or otherwise sensitive plant and animal species of the Pines Tract Project area is given in Appendix 3-9. A discussion about threatened, endangered or otherwise sensitive plant and animal species of the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). A discussion about threatened, endangered or otherwise sensitive plant and animal species of the West Coal Lease Modifications are summarized in Appendix 3-13.

Table 3-1

Federally Listed and Proposed Endangered Species in Utah

Sevier, Sanpete and Emery Counties

April 2, 2013 (2016)

Plants		**Status**	**Present**
Barneby Reed-Mustard	Schoenocrambe barnebyi	E	NP

Heliotrope Milk-Vetch	Astragalus montii	T	NP
Jones Cycladenia	Cycladenis humilis var. jonesii	T	
Last Chance Townsendia	Townsendia aprica	T	NP
San Rafael Cactus	Pediocactus despainii	E	NP
Wright Fishhook Cactus	Sclerocactus wrightiae	E	NP
Winkler Cactus	Pediocactus winkleri	T	NP
Dwarf Bear-poppy*	Arctomecon humilis	E	NP
Kodachrome Bladderpod*	Lesquerella tumulosa	E	NP
Autumn Buttercup*	Ranunculus aestivalis (acriformia)	E	NP
Mammals			
Utah Prairie Dog*	Cynomys parvidens	T	NP
Canada Lynx*	Lynx canadensis	T	NP
Desert Tortoise*	Gopherus agassizii	T	NP
Birds			
Mexican Spotted Owl *	Strix occidentalis lucida	T	NP
Southwestern Willow Flycatcher*	Empidonax traillii extimus	E	NP
Gunnison Sage-grouse*	Centrocersus minimus	T	NP
Western Yellow-billed Cuckoo*	Coccyzus americanus	T	NP
Three-toed Woodpecker	Picoides ridactytus	S	P
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
June Sucker*	Chasmistes liorus	E	NP
Greenback Cutthroat Trout*	Oncorhynchus clarki stomias	T	NP
Lahontan Cutthroat Trout*	Onxhohynchus clarkii henshawi	T	NP

Virgin River Chub*	Gila seminuda (robusta)	E	NP
Woundfin*	Plagopterus aregantissimus	E	NP

Amphibians & Reptiles

None listed in the Counties

Snails

Kanab Ambersnail*	Oxyloma haydeni kanabensis	E	NP

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, 2078 Administration Building, 1745 West 1700 South, Salt Lake City, Utah 84204-5110 Telephone:(801) 975-3300

Habitats of Unusually High Value. The area of potential impact contains a variety of important habitats for several species that are considered of "high interest" to various management agencies because these species are of economic or recreational value. There are ten recognizable vegetation habitats from a faunal standpoint: chaparral (ponderosa pine, curl-leaf mountain mahogany, manzanita, aspen), spruce-fir (englemann spruce, douglas fir, sub-alpine fir, white-fir), aspen, sagebrush, mountain brush (oak, curl-leaf mountain mahogany, smooth-leaf mountain mahogany, service berry sagebrush), streamside, pinyon-juniper, ponderosa pine, grass, and scotch pine-spruce. Conifer, aspen, high sage and meadow areas on Duncan Mountain are used as summer range and calving areas for elk and summer range for mule deer. Ponderosa pine along ridge tops are heavily used by elk during the late winter, early spring and occasionally during the summer. The cliff areas harbor mountain lion, bobcat and bear. Mountain brush habitats are heavily utilized by deer and elk during the winter and spring. Deer and elk winter on the lower elevation areas, particularly in the vegetation communities traversed by the access road (WIL, pgs. 2-3, Appendix 3-3).

Literature and field data were summarized for all terrestrial vertebrates of concern, and the species categorized to determine habitat affinities and high interest species status. These results are reported in tabular form (WIL, Tables 3 through 5, Appendix 3-3). They are listed according to their various ecological classifications. All species whose ranges appear to overlap any or all of the potential area of impact are listed. Generally speaking, the project area could potentially be inhabited by 64 mammalian, 8 amphibian and 14 reptilian species (Wasatch Plateau, Appendix 3-5). Some of these are considered high interest species for the habitats and local area of concern.

Since the immediate area of the mine portal, access roads, loading and storage facilities has already been lost as habitat, concern will be given to revegetation with species that will not only benefit, but promote wildlife.

The cliffs in Quitchupah Canyon are habitat for cougar. The observed animals seem to use them for denning activities. Therefore care has been taken to avoid placement of portal openings where there are caves or other natural denning sites. There are a limited number of trails going from the plateau area through the cliffs to the valley floor to the southeast. It appears that these trails are important to elk migration from summer to winter range, and therefore construction of ventilation portals has not been allowed to interrupt this limited number of access routes.

No endangered or threatened mammal species occur within the mine boundary as recorded in a study performed by H. Duane Smith and Clyde L. Pritchett (WIL, Appendix 3-3).

A peregrine falcon eyrie existed in 1997 about one half mile from the site but during aerial surveys conducted in 1998 and 1999 no falcons were sighted. Discussion about threatened, endangered or otherwise sensitive plant and animal species of the Pines Tract Project area is given in Appendix 3-9.

The disturbed area of the Link Canyon Mine Portals contains approximately 0.05 acres (2000 square feet) of riparian vegetation typified by willow, alder, stinging nettle, rose, horsetail, carex, Kentucky Bluegrass, rush, and clematis (Zobell, 2000). A vegetation study of the western portal area was conducted by Mt. Nebo Scientific in July 2002 and September 2013. The 2002 report of this study includes a detailed map of the western portal area vegetation. A copy of the reports are included in Appendix 2-9. The vegetation is supported by discharge from the abandoned Link Canyon Mine and subsurface moisture within the Link Canyon Drainage. Only the western-most portal area will be disturbed as part of Sufco's plan to re-open Link Canyon portals to establish an escape-way and ventilation for mining in the Pines Tract and access to the Link Canyon substation. The natural discharge of water from the portals will be maintained at rates similar to those that existed prior to reopening of the western portal. Only water from the existing abandoned works will be allowed to discharge from the portals. Thus, no harm due to a reduction in flow is anticipated to the riparian areas downstream of the portals. Additionally, the discharges from the portals have the potential to remain after the western Link Canyon Portal is reclaimed.

A vegetation study was performed by Keith Zobell from 2000 through 2013(discontinued). The reports identified the vegetation and their associated vigor at the Link Canyon Mine portal which has been similar for the past thirteen years. The primary impacts to the vegetation have been from grazing and drought conditions. Discharge for the portal has been discussed in these reports, the water discharge has been low to non-existent the majority of the years. The drainage adjacent to the portals runs with waters associated with storm events. Refer to Appendix 2-9 for a copy of the study information collected in 2013, study information from previous years is located in the annual reports for the corresponding years.

Species of High Federal or State Interest. The species of interest to the state of Utah are listed on Table 3-2. The species are divided into eight categories (extinct, extirpated, endangered, threatened, declining populations, limited distribution, declining populations/limited distribution and conservation). The Western Bluebird classified as sensitive, appears to be restricted to the Ponderosa Pine as a nesting bird. It can be locally common and its habitat is widespread over the state. It therefore does not represent any special problem in the lease area.

Sensitive Species of High Federal Interest. The species of interest to the federal Forest Service are listed on Table 3-3. The species are all sensitive as determined by the FS MLS Sensitive Species List and have the potential to occur within the permit area.

The Link Trail Columbine is the only Forest Service Region 4 sensitive species known to exist on the mine areas called the Pines Tract and Muddy Tract. SUFCO monitors populations of the Link Trail Columbine within the East Fork of the Box Canyon where it has been determined that mining might negatively affect the populations within the permit area. A discussion about threatened, endangered or otherwise sensitive plant and animal species of the Pines Tract Project area and Muddy tract is given in Appendices 3-9 and 3-11.

150-Acre Incidental Boundary Change. Sensitive species listed in Table 3-3 may be found within the boundary area. Species of most concern are the Link Trail columbine, Northern Goshawk, Northern Three-Toed Woodpecker, Flammulated Owl, and the Spotted Bat.

- Link Trail columbine - No populations have been found within the 150 acre IBC area. The boundary area is located on a plateau. Adjacent to the boundary area is Box Canyon that has suitable habit for this vegetation. A survey of the canyon will be conducted to locate representative populations of the columbine. The location of the populations of the columbine will be recorded using a topographic map and a GPS survey will be used to verify the coordinates. Photographs of the colonies will be taken during the survey. The survey will be conducted during the growing season to ensure as many colonies as reasonably possible are located.
- Northern Goshawk - No populations have been found within the 150 IBC boundary area. The Goshawk requires wooded areas for nesting and the vegetative cover of the area is generally sagebrush with few trees.
- Northern Three-Toed Woodpecker - The woodpecker is likely to use the general area but no populations have been found within the 150 acre IBC. The woodpecker requires forests containing spruce, fir, aspen, pine, and tamarack for nesting. The vegetative cover of the area is sagebrush with few trees.
- Flammulated Owl - The owl has been seen in the general area but no populations have been found within the 150 acre IBC area. The owl prefers mature ponderosa pine or Douglas fir forests with open canopies. Nests are made in large diameter dead trees with cavities. Vegetative cover of the 150 acre IBC area is sagebrush with few ponderosa pines and Douglas fir.

- Spotted Bat - The bat has been seen in both Muddy and Box Canyons. These canyons are in close proximity to the 150 acre IBC but no populations have been found within the 150 acre IBC area. The spotted bat usually roosts in rock crevices high on steep cliff faces but will inhabit Ponderosa pine, desert shrub, and pinyon-juniper stands. Few steep cliff faces are located within the 150 acres but are adjacent to the area. The 150 acres is part of a plateau and the vegetation is mainly Ponderosa pine, desert shrub, and pinyon-juniper stands.

Link Canyon Mine Portals. A few of the Sensitive species listed in Table 3-3 may be found within the portal area. The disturbed area associated with the re-opened portal is less than one acre and is included in an area previously disturbed by mining activities. No sensitive plants species were found in the area by Zobell (2000) or Mt. Nebo Scientific (2002) nor have mammals included in Table 3-3 been found in the portal area. Previous bat surveys indicated Spotted Bats are not present in the portal area. No access to the mines appear to be available to bats as the portals were completely closed by rubble in the 1980's. No Bald Eagle nests are known to occur in the area. A Peregrine Falcon eyrie was reported two miles to the east of the site in 1998 and 2001 but the eyrie was inactive in 1999, 2000 and 2002. Because the flow of water from the portals is minimal (one gallon per minute or less), fish are not found at this location. A survey specifically conducted for endangered mollusks was conducted in the portal area in June 2002. It is unlikely any endangered snails are present in the general area because of its isolated location and since the source of water only became available after the mine closed in the 1950's. Amphibians have not been reported in the area, possibly for the same reasons as those listed previously for the mollusks.

East Fork Of Box Canyon. Sufco intends to undermine portions of the East Fork of Box Canyon beginning in the Fall of 2003 through 2005 as they extract coal from the 3LPE and 4LPE longwall panels. Prior to the initiation of undermining and subsidence, a pre-subsidence qualitative evaluation of vegetation and channel conditions will be conducted in the East Fork of Box Canyon from the Joe's Mill Ponds downstream to a location above the west gate roads associated with the 3LPE panel. The survey will consist of video taping the condition of the stream channel paying particular note to surface flows and ground water discharge, vegetation types and conditions, animal species in the area including documenting the absence or presence of macroinvertabrates in the stream channel by filming the turning over of rocks or debris, general soil conditions, and the general geomorphology of the area. A qualified botanist will be used to identify and report in the video tape the major representative plant species along the stream channel. This will include riparian and spring locations found along the stream channel. Major hanging gardens will be identified and discussed. The general stream morphology will be discussed in the video including the width and depth of pools, height of natural drops, existing joints, cracks, and fractures, locations where flows naturally diminish or increase, etc.

A video tape will be made of the same portion of the East Fork at the same time of the year on the third year following undermining during September of 2008. A comparison will be made of the two tapes using the parameters described above and any changes due to mining activities will be noted. The tapes will be submitted to the Division as part of the Annual Report; the Fall 2003 video tape will be submitted with the 2003 Annual Report and the comparison tape will be submitted with the 2008 Annual Report.

Fourteen sites have been identified and established during the qualitative pre-subsidence survey for use in a quantitative evaluation of site-specific vegetative and hydrologic conditions (See Chapter 7 Section 7.3.1.2) The site locations have been mapped and identified in the field with stakes and flagging. The sites include each of the springs found within the portion of the East Fork to be subsided and the Joe's Mill pond area.

A survey of the identified stream and spring monitoring sites will include a concentrated study of vegetative communities associated with the stream and spring sites. The vegetative survey of the East Fork will be conducted following the USFS and D.L. Rosgen stream channel survey protocol. The condition of the riparian vegetation flanking the channel at each of the sites will be described and the hillsides above the channels will also be monitored for changes in morphology. Maps of the surveyed areas will be prepared. The survey will be conducted before subsidence begins in the effected areas of Box Canyon Creek and will be repeated in 2004, 2005, 2006, and 2008.

The conditions of the vegetation at the spring sites will be monitored for the same parameters as the stream sites. The source and discharge area will be included in the survey. Photographs will be obtained at each of the monitoring stations of the vegetative communities along the stream channel, hillsides above the site, and at the spring locations. Permanent photo points will be established to allow for repeatability of photographing the vegetation.

Qualitative surveys of the vegetation at each monitoring station will be conducted twice per year, once at the beginning of the growing season and again at the end of the season, for the first three years as mining is commenced in the East Fork and then in the fifth year following undermining. The surveys will include observations of the conditions, types, notable changes, etc., of the vegetation in the Joe's Mill pond area vegetation and along stream banks and spring locations identified as monitoring sites.

Erosion of the hillsides will be monitored during the twice yearly qualitative vegetation survey using a numerical ranking system to identify the degree of erosion. The ranking system will be as follows:

4-Extreme erosion	deeply incised rills and gullies with unstable, actively slumping walls and loose material moving rapidly to the rill or gully floor, freshly exposed plant roots, no remaining topsoil, no vegetative litter, little to no vegetative cover.
3-High erosion	incised rills and gullies slightly unstable slopes, only occasional slumps of the rill or gully wall, some plant roots exposed, little to no topsoil remaining, little to no vegetative litter, poor vegetative cover.
2-Moderate erosion	small rills, no gullies, moderately stable slopes, very little to no exposed roots, most of the topsoil remains, moderate vegetative cover.
1-Slight erosion	occasional small rills, no significant channeling in the soils, no exposed roots, topsoil remains, most vegetative litter in place, good vegetative cover.

0-No erosion	Appears relatively undisturbed, essentially no rills, vegetative litter in-place, healthy vegetative cover.

Photographic evidence of the state of erosion will be obtained each year at the East Fork monitoring sites for annual comparative and evaluation purposes. The climatic and overall vegetative conditions of the area will be noted. Particular attention will be paid to the effects of grazing on the vegetation and soils with respect to changes in the rank of erosion.

As part of the quantitative evaluation of the East Fork of Box Canyon, the locations of populations of the Link Canyon Columbine will be identified, mapped, and locations staked. The number of individuals in the populations will be counted or accurately estimated. All other populations of Threatened and Endangered and Sensitive Species found in the area of concern will be identified. The population location will be mapped, if appropriate, and the number of individuals will be recorded. The surveys of the TEC and Sensitive Species, if found, will be repeated in 2004, 2005, 2006, and 2008.

A low level, colored infrared aerial survey will be conducted of the East Fork of Box Canyon in 2003 and in 2008. The survey will include the stream and spring monitoring points. The results of the survey will be reported to the Division in the mine's Annual Report in the year following the survey.

The vegetative, erosion, and colored infrared survey reports will be submitted to the Division as part of the annual report according to the schedule provided below. Two copies of the reports will be sent to the Division so that they may forward one copy to the Manti-LaSal National Forest.

1. 2003 Baseline Vegetation Report to be submitted with the mine's 2004 Annual Report. Also includes baseline colored infrared aerial photos and report of the monitored stream and spring areas within the east Fork of Box Canyon

2. Both 2004 Quantitative and Qualitative Vegetation Reports for the 1st year data collected following undermining will be submitted in the 2005 Annual Report.

3. 2005 Qualitative Vegetation Reports for the 2nd year following undermining will be submitted in the 2006 Annual Report. The Qualitative surveys only will be conducted.

4. 2006 Quantitative and Qualitative Vegetation Reports for the 3rd year following undermining will be submitted in the 2007 Annual Report.

5. 2008 Quantitative and Qualitative Vegetation Reports for the 5th year following undermining will be submitted in the 2009 Annual Report. Also includes the colored infrared aerial photos and report of the monitored stream and spring areas within the East Fork of Box Canyon.

If substantiated mining-induced changes occur in the vegetation within the affected areas of the East Fork of Box Canyon, a revegetation/enhancement mitigation plan will be created and submitted to the Division. The permittee understands that the mitigation plan will be approved only after the Division consults with the USFS on the proposed plan.

In addition to the East Fork of Box Canyon vegetative monitoring and mitigation plan, Sufco will implement a hydrologic monitoring plan as well as a stream channel subsidence crack mitigation plan. These plans are discussed in greater detail in Section 7.3.1.2 and Section 5.2.5.1 of this M&RP. Mitigation of cracks, if they occur, in the bottom of the stream channel requires the placement of bentonite grout to stop the diversion of surface flows. If mitigation is required during the critical elk and deer time periods of November 1st through April 1st and May 1st through July 1st, or during the raptor nesting and rearing season of February 1st through August 31st, the Division will be contacted and the mitigation plans reviewed with the appropriate regulatory personnel. Mitigation work will be performed in such a manner as to minimize disturbance to wildlife.

A baseline macroinvertebrate survey was performed on the East Fork of the Box Canyon on October 20, 2003 by Dr. Dennis K. Shiozawa with assistance from Patrick Collins of Mt. Nebo Scientific. Ms. Katherine Foster of the Manti-LaSal National Forest was also present during the survey. Locations of the macroinvertebrate populations survey were determined based on the stream channel floor conditions, availability of water, and potential repeatability of the survey. Sites in the area of EFB-4 were not acceptable to Dr. Shiozawa since the channel floor was not stable and consisted of loose sand. The current environmental conditions, specifically the channel floor configuration, would likely be changing naturally over time and with every significant precipitation event. These naturally occurring changes would make repeating the survey in these types of locations very difficult at best. Additionally, the loose sands that formed the channel floor are abrasive and very detrimental to macroinvertebrate life. The movement of sand through the system as a result of a precipitation event could easily significantly diminish or destroy populations. Therefore, four locations were selected in the area of and upstream of site EFB-11. These locations appeared to have the most stable channel floor, bed rock, and repeatability of the survey at these locations would be possible.

The survey consisted of obtaining two sample sets from each site. The organisms captured at each site will be identified to the species level. The number of organisms per unit of measure were counted and recorded. Two copies of the results of this baseline survey will be submitted to the Division with the 2004 Annual Report. A second and third survey will be performed in 2004 and 2005 following undermining and two copies of the results will be submitted to the Division with the 2005 and 2006 Annual Reports.

A copy of the October 2003 "Monitoring and Mitigation Plan for Mining Under the East Fork of Box Canyon" prepared by the Division and reviewed and accepted by the Forest with some modifications has been included in Appendix 3-10. The preceding paragraphs have been prepared based on this plan. Sufco will meet all of the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the East Fork of Box Canyon.

Federally-listed threatened, endangered, proposed or candidate plant species are know to occur within the Greens Hollow Tract or the extended area analyzed in the FSEIS. According to evaluations by various agencies there is a potential for habitat for several other species to be available within the tract (Appendix 3-15).

3.2.2.3 Fish and Wildlife Service Review

If requested, the applicant authorizes the release of information pertaining to Section 3.2.2 and 3.3.3 to the U.S. Fish and Wildlife Service Regional and Field office for their review.

3.2.3 Maps and Aerial Photographs

The lease area was mapped by use of a mosaic of aerial photographs and assured by ground inspection. Vegetation sampling locations/reference areas are shown on Plate 3-1.

3.2.3.1 Location and Boundary of Proposed Reference Area

The locations of the vegetative reference areas are found on Plate 3-1. Area 13 shown on Plate 3-1 is to be used as a mapping unit only and not a reference area or validation site. Site 12 will be used as the reference area for the minesite sedimentation pond area.

3.2.3.2 Elevations and Locations of Monitoring Stations

Raptor nest locations and elk and deer range are shown on Plate 3-2 and 3-3. The permit area contains no fish monitoring stations.

3.2.3.3 Facilities for Protection and Enhancement

Sections 3.3.3.3 and 3.5.8.5 contain additional discussion pertaining to protective measures taken by the applicant in behalf of wildlife.

Power lines within the SUFCO Mine permit area were modified during the summer of 1981 to comply with the guidelines of REA Bulletin 61-10, "Power Line Contacts by Eagles and Other Large Birds" (see Plate 5-5 for the power pole locations).

3.2.3.4 Vegetation Type and Plant Communities

Vegetative types and plant communities are outlined on Plate 3-1 of this application.

Table 3-2

Utah Wildlife Species of Special Interest - Sevier, Sanpete and Emery Counties

~~March 29, 2011~~ October 1, 2015

Mammals		**State Status**
Brown (Grizzly) Bear	Ursus arctos	S-ESA (S,SV)
Black-footed Ferret	Mustela nigripes	S-ESA (E)
Utah Prairie Dog	Cynomys parvidens	S-ESA (S,SV)
Fringed Myotis	Myotis thysanodes	SPC (SV)
Big Free-tailed Bat	Nyctinomops macrotis	SPC (SV
Townsend's Big-eared Bat	Plecotus townsendii	SPC (E,S,SV)
Canada Lynx	Lynx canadensis	S-ESA (E,S,SV)
Kit Fox	Vulpes macrotis	SPC (E,S,SV)
White-tailed Prairie-dog	Cynomys leucurus	SPC (E)
Pygmy Rabbit	Brachylagus idahoensis	SPC (SV)
Birds		
Southwestern Willow Flycatcher	Empidonax traillii extimus	S-ESA
Bald Eagle	Haliaeetus leucocephalus	SPC (E,S,SV)
Ferruginous Hawk	Buteo regalis	SPC (E,S,SV)
Yellow-billed Cuckoo	Coccyzus americanus occidentalis[3]	S-ESA
Spotted (Mexican) Owl	Strix occidentalis[2]	S-ESA
Northern Goshawk	Accipiter gentilis	CS (E,S,SV)
Burrowing Owl	Athene cunicularia	SPC (E,S,SV)
Short-eared Owl	Asio flammeus	SPC (SV)
American White Pelican	Pelecanus erythrorhynchos	SPC (SV
Three-toed Woodpecker	Picoides tridactylus	SPC (S,SV
Greater Sage-Grouse	Centrocercus urophasianus	SPC (E,S,SV)
Long-billed Curlew	Numenius americanus	SPC (S,SV)
Black Swift	Cypseloides niger	SPC (SV)
Lewis's Woodpecker	Melanerpes lewis	SPC (S)
Grasshopper Sparrow	Ammodramus savannarum	SPC (S)
Fish		
Bonytail	Gila elegans	S-ESA (E)
Humpback Chub	Gila cypha	S-ESA (E)
Razorback Sucker	Xyrauchen texanus	S-ESA (E)
Roundtail Chub	Gila robusta	CS (E)

Flannelmouth Sucker	Catostomus latipinnis	CS (E)
Bluehead Sucker	Catostomus discobolus	CS (E,S
Colorado River Cutthroat Trout	Oncorhynchus clarki pleuriticus	CS (E,S,SV)
Bonneville Cutthroat Trout	Oncorhynchus clarki utah	CS (S,SV
Colorado Pikeminnow	Ptychocheilus lucius	S-ESA (E)
Southern Leatherside Chub	Lepicomeda aliciae	SPC (S,SV)
Reptiles and Amphibians		
Western (Boreal) Toad	Bufo boreas	SPC (E,S,SV)
Great Plains Toad	Bufo cognatus	SPC (E)
Mollusk		
Carinate Glenwood Pyrg	Pyrgulopsis inopinata	SPC (SV)
Otter Creek Pyrg	Pyrgulopsis fusca	SPC (SV)
Smooth Glenwood Pyrg	Pyrgulopsis chamberlini	SPC (SV)
Ninemile Pyrg	Pyrgulopsis nonaria	SPC (S)
South Bonneville Springsnail	Pyrgulopsis transversa	SPC (S)

None of these species are known to be located in the mine lease area.

Key to State Status Field (Table 3-2)

Symbol	Definition
S-ESA	Federally-listed or candidate species under the Endangered Species Act.
SPC	Wildlife species of concern.
CS	Species receiving special management under a Conservation Agreement in order to preclude the need for Federal listing.
E	Emery County List
S	Sanpete County List
SV	Sevier County List

Utah Division of Wildlife Resources, 1596 West North Temple, Salt Lake City, Utah 84116-3195
Utah Natural Heritage Program's Biodiversity Tracking and Conservation System (BIOTICS)

Table 3-3
USDA-FS Region 4 Sensitive Species - Fishlake and Manti-LaSal
February 2013 Update (2016)

Plants		Status	Present
Link Trail Columbine*	Aquilegia flavescens var. rubicunda	K	NP
Cruetzfeldt-flower Cryptanth*	Cryptantha creutzfeldii	K	NP
Carrington Daisy*	Erigeron carringtoniae	K	NP
Canyon Sweetvetch*	Hedysarum occidentale var. canone	K	NP
Maguire Campion*	Silene petersonii	K	NP
Arizona Willow*	Salix arizonica	K	NP
Wonderland Alice Flower*	Aliciella caespitosa	K	NP
Chatterley Onion*	Allium geyeri var. chatterleyi	K	NP
Sweet-flower Rock Jasmine*	Androsace chamaejasme ssp. Carinata	K	NP
Bicknell Milkvetch*	Astragalus consobrinus	K	NP
Isely's Milkvetch*	Astragalus iselyi	K	NP
Tushar Paintbrush*	Castilleja parvula var. parvula	K	NP
Pinnate Spring-parsley*	Cymopterus beckii	K	NP
Abajo Peak Draba*	Draba abajoensis	K	NP
Mt. Belknap Draba*	Draba ramulosa	K	NP
Creeping Draba*	Draba sobolifera	K	NP
Nevada Willowherb*	Epilobium nevadense	K	NP
Abajo Daisy*	Erigeron abajoensis	K	NP
Kachina Daisy*	Erigeron kachinensis	K	NP
Maquire Daisy*	Erigeron maguirei	K	NP
LaSal Daisy*	Erigeron mancus	K	NP
Elsinore Buckwheat*	Eriogonum batemanii var. ostlundii	K	NP
Canyonlands Lomatium*	Lomatium latilobum	K	NP
Fish Lake Naiad*	Nafas caespitosa	K	NP
Beaver Mountain Groundsel*	Packera castoreus	K	NP
Little Penstemon*	Penstemon parvus	K	NP
Ward Beardtongue Penstemon*	Penstemon wardii	K	NP
Bicknell Thelesperma*	Thelesperma subnudum var. alpinum	K	NP
Barneby Woody Aster*	Tonestus kingii var. barnebyana	K	NP
Sevier Townsendia*	Townsendia jonesii var. lutea	K	NP
San Rafael Cactus*	Pediocactus despainii	K	NP
Clay Phacelia*	Phacelia argillacea	K	NP
Last Chance Townsendia*	Townsendia aprica	K	NP
Ute Ladies'Tresses Orchid*	Spiranthes diluvialis	K	NP

Heliotrope Milk-Vetch*	Astragalus montii	K	NP
Winkler Cactus*	Pediocactus winkleri	K	NP
Desert Milk-Vetch*	Astragalus desereticus	K	NP
Mammals			
Townsend's Western Big-eared Bat*	Corynothinus townsedii townsendii	K	NP
Spotted Bat*	Euderma maculatum	K	NP
Bighorn Sheep*	Ovis canadensis	K	NP
Pygmy Rabbit*	Brachylagus idahoensis	K	NP
Utah Prairie Dog*	Cynomys parvidens	K	NP
Birds			
Northern Goshawk*	Accipiter gentilis	K	P
Flammulated Owl*	Otus flammeolus	K	P
Northern Three-toed Woodpecker*	Picoides tridactylus	K	P
Bald Eagle*	Haliaeetus leucocephalus	K	P
Greater Sage-grouse*	Centrocercus urophasianus	K	P
Peregrine Falcon*	Falco peregrinus anatum	K	P
Yellow-billed Cuckoo*	Coccyzus americanus	K	NP
Southwestern Willow Flycatcher*	Empidonax traillii extimus	K	NP
Mexican Spotted Owl*	Strix occidentalis lucida	k	NP
Fish			
Colorado River Cutthroat Trout*	Oncorhynchus clarki pleuriticus	K	NP
Bonneville Cutthroat Trout*	Oncorhynchus clarki utah	K	NP
Southern Leatherside Chub*	Lepidomeda aliciae	K	NP
Greenback Cutthroat Trout*	Oncorhynchus clarki stomias	K	NP
Amphibians			
Columbia Spotted Frog*	Rana luteiventris	K	NP
Boreal Toad*	Bufo boreas	K	NP

K - Known distribution species and or habitat
P - Suspected species or potential habitat NP- Not Present (BLM FSEIS)

USDA-Manti-LaSal National Forest, 599 Price River Dr., Price , Utah 84501

3.30 Operation Plan

3.3.1 Measures Taken to Disturb the Smallest Practicable Area

No vegetative disturbance is anticipated beyond that encountered during exploratory drilling, portal site construction or that created by subsidence. New operational facilities are kept to a minimum. Only facilities required to maintain the coal operation or satisfy environmental or safety requirements are built.

Revegetation methods to be used to temporarily stabilize are described according to degree of slope angle and accessibility. Interim stabilization is discussed in Section 3.5.2.

The seed mixture (see Section 3.4.1) will be used to revegetate areas disturbed by mining and all associated activities. The climate of the area was reviewed to assess the need for drought-tolerance in the species selected for the seed mixture. The vegetation report (Appendix 2-2) was evaluated to determine seed mixture constituents in light of production, cover, and diversity requirements. The soils report was reviewed to select species adapted to the soil's physical and chemical condition. Plant species were selected on the basis of wildlife needs and requirements. In addition, the operations plan was reviewed to determine the need for species with quick establishment, rapid spreading and high erosion control potentials.

3.3.2 Description of Anticipated Impacts of Subsidence

Surface disturbance associated with certain mining operations and techniques can be extremely detrimental to terrestrial and aquatic vertebrates, but the longwall technique used within the SUFCO Mine minimizes much of the impact. Since no overburden is removed, the major problem is surface subsidence. The acreage that will be undermined may subside up to a maximum of 70 percent of the thickness of the mined coal. Similarly mined areas in comparable habitats in New Mexico have experienced less than 12 percent subsidence with little or no visible disturbance. The existing mined area has subsided and shows minor surface fissures. It is probable that the integrity of the above ground terrestrial vertebrate communities will generally remain status quo, with occurrence of occasional fractures and minor slippages that will not be detrimental to vegetation or wildlife. Credibility to this statement comes from the lack of detectable differences in terrestrial vertebrates in comparable habitats in expansion areas.

Subterranean changes, however, are not currently fully understood. There is the possibility that when subsidence occurs, it will disrupt burrow systems and underground aquifers. The loss of the burrow system will destroy the home and habitat of fossorial mammals, reptiles and amphibians and possibly cause death to some species in the immediate area at the time of collapse. If subsidence were to occur simultaneously and non-uniformly over the entire area of concern, this would be a major problem not only for the prey species, but particularly for predators dependent upon the prey base. However, since subsidence will occur systematically and in small areas at a given time, only localized populations will be impacted and only for a short while. Reproductive potential coupled with dispersal will facilitate almost immediate recovery and negate the temporary population reduction. There are no threatened nor endangered species present in the area, so none will be impacted. It has also been observed that burrowing mammals frequently make new dwellings along subsidence induced fractures.

The question of underground aquifer disruption is not easily dismissed. The geology and hydrological system in this area has been studied for several years. Surface waters and habitats are significant resources to elk and deer during the late summer months when water becomes the limiting resource to habitat utilization. Alteration of the groundwater resources would be serious, not to the perpetuation of the population and herds as an entity, but to harvestable productivity. Such habitat loss would also be detrimental to amphibians and aquatic dependent reptiles.

3.3.3 Plan to Minimize Disturbances and Adverse Impacts

In new mine operations it is easy to suggest, provide and implement mitigative measures. But in the case of the SUFCO Mine, preconstruction design and associated mitigation does not apply nor can it be implemented without major additions or modifications. The mine has been operating approximately 55 years, and little can or should now be done to change the design of the portal facilities to lessen the impacts. Any significant change now would increase impacts. Any species inhabiting and utilizing the area of concern have likely habituated to the present facilities and consequently adjusted their behavior including migration so that change would be more impacting than status quo.

Construction of additional ventilation portals could potentially cause problems. These portals will be opened to the outside from the underground mine entries. Chainlink fence is placed over the portal opening, to protect wildlife from harm. These portals will be placed so that no major big game migration trails are interrupted and no caves or natural cougar denning or resting ledges are destroyed.

Noise, created from operation of the mine, is not expected to increase in the existing areas of disturbance associated with the mining activity, not even with the addition of any ventilation intake portals along the cliffs. These portals are only for intake air. The present exhaust fans are at the mine site and at the 4 East Portal in Quitchupah Canyon.

Appendix 3-15 contains a sound monitoring report conducted by Tetra Tech, Inc in 2008. The monitoring was conducted to collect baseline data in association with the potential development and operation of a ventilation shaft near Quitchupah Canyon. The data was collected around an existing ventilation fan and at selected sensitive resource location such as Forest System Roads, and Greater Sage-grouse leks. The collected sound level data will be used to determine measures which could reduce sound related impacts associated with the operation of the proposed ventilation fan.

Sound level measurements taken within the resource locations ranged between 27.6 dBA and 70.3 dBA. Sounds from the existing fan were discernable at the leks and forest service roads, however most were at or near the background sound levels. Refer to Table 1 for average, minimum and maximum levels at each location.

Efforts have already been made to minimize wildlife loss and/or harassment associated with operation of the mine. Speed limits are set and posted on the county controlled access road to the mine to alert drivers to the presence of wildlife. Although the danger of road strikes is more harmful to wildlife than transportation vehicles, there is the potential for loss of human life and equipment damage. Therefore avoiding collisions has become a practical company policy. Wildlife crossing areas or sites of limited visibility are adequately marked. The applicant has instituted the use of a commuter bus to reduce traffic and emissions on the access road from Salina, Utah to the mine. SUFCO prohibits the discharge of firearms by employees on the road in East Spring Canyon (portal site). In conjunction with this restriction, the Applicant has initiated an employee education program to reduce harassment and disturbance of wildlife during sensitive stages in their life history.

Perhaps the most promising mitigation action is that of enhancement or maintenance of wildlife habitat. Enhancing wildlife habitat away from the mine area will improve habitat, possibly increase wildlife numbers, and attract wildlife away from impacted areas. Since much of the area is public domain, wildlife habitat enhancement is a viable management tool. However, any such effort should be carefully coordinated among appropriate regulatory agencies. Some examples of these measures include:

1. Development of springs, wells or other water supplies outside the mine area.
2. Fencing of developed water sources to restrict cattle trampling of vegetation, control erosion, and provide non-game habitat;
3. Altered livestock management policies, to avoid potential competition with wildlife.
4. Control of other human-related impacts, including recreation and timber harvest.

Revegetation of disturbed areas, as part of the reclamation effort, will include a mixture of grasses, forbs, shrubs and trees.

The total disturbed area acreage to be revegetated is small enough that fencing is considered to be an economically feasible means of protection, if deemed necessary. If grazing animals do prove detrimental to revegetation attempts, measures will be implemented following consultation with the regulatory authorities.

Water is perhaps the most limiting resource and as mentioned in the subsidence discussion, the present resources must not be decreased. The applicant herein commits to restore stream water resources in addition to previously identified springs which are contaminated, diminished, or interrupted as a result of the applicant's underground coal mining activities and which will not obviously be restored naturally within a reasonable period of time.

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.

1. Mining Consumption

Water used underground to mine coal:

2.29% moisture added to coal by cutting and dust suppression operations

Projected 2005 tonnage of coal mined	7,605,685 tons
Projected 5-year average tonnage of coal mined	7,510,217 tons
Tons water/year (based on projected 5 yr average)	171,984 tons
Pounds water/yr	343,967,939 pounds
Gallons/year (8.337 lbs/gal of water)	41,257,999 gallons
Acre feet/year	126.62 ac-ft

2. Ventilation Consumption

33,068 gallons/day (05/02 ventilation survey)

33,068 gallons/day x 365 days/year = 12,069,820 gallons/year = 37.05 ac-ft/year

3. Coal Producing Consumption

No washing or processing of coal involving water occurs at the Sufco Mine. Therefore, Coal Producing Consumption = 0 ac-ft/yr

4. Sediment Pond Evaporation

Mine Site Pond 0.236 acres (surface area)

Evaporation 18.1 in/yr

18.1 in/yr = 1.508 ft/yr

1.508 ft/yr x 0.236 acres = 0.356 ac-ft/yr

Waste Rock Pond 0.219 acres (surface area)

Evaporation 18.1 in/yr

18.1 in/yr = 1.508 ft/yr

1.508 ft/yr x 0.236 acres = 0.330 ac-ft/yr

Total Annual Pond Evaporation = 0.686 ac-ft/yr

5. Subsidence Effects on Springs and Seeps

Spring Pines 303 appears to have reduced flow due to mining. Prior to mining, flow appears to have averaged about 2.8 gpm (Pines EIS data). The flow was reduced to 0 gpm by late summer 2001. Flow measured in summer of 2005 indicated the flow is returning at a rate of about 0.17 gpm. Assuming the flow stabilizes at 0.2 gpm, the 2005 reduction of flow is 2.6 gpm. Note: The spring flow may return to its premining rate over time as the drained aquifer recovers. Modification to this calculation will then be required.

2.6 gpm x 1440 min/day x 365 days/yr = 1,366,560 gal/yr

Annual reduction in flow in 2005 = 1,366,560 gal/yr ÷ 325,850 gal/ac-ft = 4.2 ac-ft/yr

6. Alluvial Well Pumpage

Sufco does not pump water from an alluvial well.

7. Alluvial Aquifer Abstractions into Mine

The mine has not created alluvial aquifer abstractions into the mine.

8. Deep Aquifer Pumpage

Sufco does not pump from deep aquifers.

9. Postmining Inflow to Workings

Current data indicates postmining inflows to the mine will be minimal and from aquifers storing water several thousand years old. Inflows will not consist of intercepted surface water or ground water that would discharge to the surface at a perceptible rate.

10. Coal Moisture Loss

8.34% inherent moisture - source Sufco Geologist

Projected Tonnage 2005	7,605,685 tons
Tons water/yr	634,314 tons
Pounds water/yr	1,268,628,258 pounds
Gallons water/yr	152,168,437 = 466.9 ac-ft/yr

* This amount of water is *not* included in the overall calculation of the water removed from the drainage system since it is inherent moisture (water locked in the coal) and is not considered as part of the active or inactive ground water system.

11. Direct Diversions

Culinary Water - from spring (Water Right 94-87) = 10.50 ac-ft (2004 consumption)

Mine Discharge:

2004 Average 4,948,260gpd = 1,806,114,900 gal/yr = 5544.3 ac-ft/yr.

Consumption Volume from items 1 - 11 above = 179.1 ac-ft/yr

Total mining operations net water gain/loss = 5365.2 ac-ft/yr gain.

Deer regularly migrate through and graze in the surface facilities and down the canyons to lower altitudes during severe winters. Numerous side canyons to Convulsion Canyon have been left undisturbed to allow uninterrupted big game movement.

3.3.3.1 Minimized Disturbance to Endangered or Threatened Species

The applicant will apply all methods necessary to minimize disturbances or any adverse effects to species listed on Tables 3-1 and 3-2. Potentially adverse impact on wildlife and related environmental values will be avoided or minimized through the implementation of mitigation measures. The Applicant will operate and maintain all transportation systems and support facilities under its control in a manner that minimizes impacts.

3.3.3.2 Species and Habitats

All species and habitats within the permit area will be protected to the best of the applicants ability. Wildlife habitat protection will be considered in the construction of all future facilities. For additional information, see Section 3.3.3.3.

3.3.3.3 Protective Measures

The county access road traverses known deer winter range where deer feed along and readily cross the road making them vulnerable to the coal hauling trucks. Although deer can habituate to traffic thus reducing road strikes, more deaths occur than are desirable.

In the construction of the ventilation portals along canyon walls consideration is given to potential cougar denning and resting sites. When portals are opened to the outside from the underground mine and not from the outside in, little actual habitat is lost to the wildlife of the area.

During breeding seasons, disturbance by man can negatively affect reproductive success by disrupting territorial selection or defense, interrupting courtship displays and disturbing mating animals.

Young animals need to be undisturbed during parturition, lactation and the early rearing process. It is during this time that young animals gain the strength and ability to elude predators and man. Undisturbed habitats allow the young animals to develop in a relatively unstressed situation and to utilize habitats that are secure from predators.

The company will make every effort to educate all employees associated with the SUFCO Mine operation to the intricate values of the wildlife resources associated with the mine area. Each employee will be advised not to unnecessarily or without proper permits or licenses harass or take any wildlife. It is especially important that wildlife not be harassed during sensitive periods in their life history. During winter, wildlife are often in a delicate energy state and unnecessary disturbance by man causes them to use up critical and limited energy reserves that may result in mortality. In less severe cases the fetus being carried by gestating mammals may be reabsorbed or aborted thus reducing reproductive success and productivity of the population. Surface activities are curtailed from November 1 through April 1, and between May 1 and July 1 in the calving area, except in the portal areas, so as not to disturb wintering elk. Employees will be encouraged to report violators to the proper company and management authorities for reprimand or prosecution. Employees should be impressed that they as hunting and recreation users stand to gain the most by preserving what they have in proximity to their places of work and abode.

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 a seed mix appropriate to the area and one approved by the Division and land owner/agency. Several such mitigation efforts have already been successfully conducted in the Quitchupah and Pines Tract areas.

Subsidence induced seismicity has not been noted to have an adverse impact on livestock or wildlife in the existing mined portions of the Sufco permit area. It is not anticipated the impact to wildlife and livestock due to mining induced seismicity will change or increase as the permit area is expanded into new lease areas.

Areas with suitable habitat for raptor nesting that have a potential to be disturbed by subsidence caused by mining will be surveyed using aerial or ground surveys prior to mining. Raptor nests that have a potential to be disturbed by subsidence will be evaluated with the Division of Oil Gas and Mining and with DWR/FWS if required Following the evaluation an appropriate plan of action will be developed on a case by case basis. The applicant will obtain any permits necessary for disturbance of the nest if this is the course of action decided upon.

A summary of the information reported in the raptor survey (annual) and the survey will be provided to the Division within three months following the receipt and review of the survey by the permittee. The summary will include a drawing correlating the surveyed nest locations with the areas of potential subsidence anticipated at the time of report submittal.

The Link Canyon Substation No. 1 pad area has an old historic golden eagle nest (#31) that was not found during the 1997 Raptor Survey and a tended falcon scrape (#33) within the buffer zone. These two nests will not be disturbed with the planned mining activity. To protect these nests during the construction of the Substation No. 1 pad the nests will be avoided, and the timing of the construction activity will be after the nesting period of August 15, 1998.

In Link Canyon during the 1998 Raptor Survey a new tended golden eagle nest was found (#321) and the other old historic golden eagle nest sites (#31, and #32) and the falcon scrape (#33) were not found.

In Link Canyon during the 1999 Raptor Survey the golden eagle nest (#321) was inactive and the other old historic golden eagle nest sites (#31, and #32) and the falcon scrape (#33) were not found. Golden eagle site #32 was renumbered in the 1999 survey as #799 and the old historic site #31 shown next to the Link Canyon road and Substation No. 1 pad was deleted.

To protect these nests during the construction of the Substation No. 2 pad the nests will be avoided. The timing of the construction activity started on October 15, 1999 with the construction of a small 20'x 30' pad for drilling the power cable boreholes out from within the mine, casing the boreholes, and pulling power cables into the boreholes. The construction of the proposed Substation No. 2 pad and substation will be started right after the drilling and power cables are completed in February, weather permitting. Construction activities began before and continues into the nesting season, any birds wanting to use these old nests in the area would be able to choose if they can tolerate the disturbance. These nests will be monitored during the construction period to see if they are being used.

After the Link Canyon Substation is in place very little mining activity will occur in the area with only emergency maintenance and monthly electrical inspections required. This maintenance and inspection activity will be similar to general public access on the road. Minor maintenance and monthly inspections will only require a pickup truck, ATV or snowmobile going up the canyon for access to the substation.

Any major maintenance requiring heavy construction equipment will require monitoring from December 1 to April 15 for big game winter range and from January 1 to August 15 for raptors and will require a clearance from the DWR and USFS.

Construction associated with the reopening of the western Link Canyon Mine portal, will require minimizing activities that disturb big game from December 1 to April 15. Construction activities from January 1 to August 15 will require a clearance from the DWR and US Fish and Wildlife Service because of potential disturbance to nesting raptors. This proposed project is located in a MMA (Minerals Management Area) in the Manti-La Sal forest plan (Figure 3-15, Management Area Direction, Manti-La Sal National Forest Pines Tract Project, Final Environmental Impact Statement, January 1999). A GWR (General Big-Game Winter Range) Management Unit is located adjacent to the MMA Management Unit. Although this direction does not apply to the adjacent MMA Management Unit where the current proposal is located, the Manti-La Sal National Forest Record of Decision considered this management direction. Direction for operations in adjacent GWR Management Units calls for minimizing potential conflicts. The current proposal will have negligible effects to wintering big game because there will be very little activity at the site following the initial short-term construction activity (pages 14-15, Manti-La Sal National Forest, SUFCO Mine Link Canyon Portal Record of Decision, Oct.

10, 2002). The area will be surveyed for raptor nests. If any are found within the prescribed buffer zone, they will be monitored for activity and work at the portal site will occur following the same guidelines as those described for the Link Canyon Substation.

Mining within the SITLA Muddy Tract will be limited to underground activities; no surface disturbance, other than exploration drilling, is anticipated in this area. Exploration drilling is typically handled by the Division under a separate permit application process. No known raptor nests are known to exist within the SITLA Muddy tract where subsidence will occur. However, if future raptor monitoring finds any raptor nest that has a potential to be disturbed by subsidence, the nest and potential damage will be evaluated with DWR and FWS. An appropriate plan of action will be developed on a case by case basis. The Division of Oil Gas and Mining will be informed in advance when such an evaluation is necessary. The applicant will obtain any permits necessary for disturbance of the nest if this is the course of action decided upon.

Generally, vegetation within the lease and permit areas outside of disturbed areas is protected from mining related impacts, such as subsidence, by the depth of overburden and depth of soil. Experience in mining the Pines and Quitchupah leases has shown that upland vegetation does not appear to be significantly affected by subsidence. Cracks that form in the soil tend to heal quickly and the majority of the vegetation in the area of surface cracks does not appear to be suffering from undue stress. The only cases of damage to vegetation related to mining appears to occur when subsidence cracks form in areas where a brittle sandstone body is near the surface with little soil cover and a crack either visibly bifurcates a plants root system or opens wide enough for soils and small plants to fall into. In a few locations, tree roots have been weakened by surface cracks and have resulted in the trees toppling shortly after the cracking occurs. This impact appears to be typically limited to areas near a canyon rim such as in the West and East Forks of Box Canyon. In areas where there are at least a few feet of soils over bedrock, such as in the previously mined portions of the Quitchupah Lease, this phenomenon has not been observed. Significant impacts to upland vegetation from subsidence are not anticipated in the SITLA Muddy Tract since most of the tract area has a relatively thick mantle of soils.

The depth of overburden in the SITLA Muddy Tract ranges from 900 to nearly 2200 feet. Areas projected to be undermined are covered by a minimum of 1000 feet to a maximum of 2100 feet. Most of the vegetation in the tract is found to be growing in the Price River and the North Horn Formations where the depth of cover is at least 1000 feet. Where these formations are exposed to mining induced subsidence in the Sufco area, the formations tend to react more plastic than brittle and subsidence crack formation is often muted. Subsidence cracks in thick soils and heavily weathered bedrock near the ground surface will frequently heal or fill in a relatively short period of time. Because of the depth and type of cover, Sufco anticipates there will be little impact to upland vegetation due to the subsidence. Subsidence cracks that form that are determined to be a safety hazard will be mitigated as discussed previously in this section.

The applicant has implemented a program to monitor the effect of subsidence on the vegetative communities. The applicant uses color infrared photography (CIR) to document changes to vegetation. This CIR coverage was begun in 1987 and will be updated at least every 5 years.

The riparian vegetation within upper Box Canyon adjacent to the 150 acre lease modification is of special concern to the permitting agencies and the permittee. Because of this concern, SUFCO commits to monitoring the effects of subsidence on the riparian vegetation within the upper Box Canyon by including this area within the color infrared photography monitoring program described in the preceding paragraph. Previous infrared surveys have included most of the 150 acre lease modification area and upper Box Canyon. These previous surveys will be used to provide baseline data for the monitoring of subsidence effects, if they occur, on the riparian vegetation within the area. This data will be reviewed by qualified personnel to make determinations concerning the effects of subsidence on the riparian vegetation.

A survey will be conducted to locate representative populations of vegetation growing within bedding planes and fractures in the walls of Box Canyon. The location of the populations will be recorded using a topographic map and a GPS survey will be used to verify the coordinates. Photographs of the vegetation will be taken during the survey. The survey will be conducted during the growing season through 2013, when the survey was discontinued. This survey may coincide with the survey for the Link Trail Columbine as discussed previously in this chapter. A report of this survey will be included in the SUFCO annual report through 2012, a summary of the reports including the information gathered in 2013 is located in Appendix 3-10.

The applicant has implemented a program to monitor surface flowing water to determine diminished flows resulting from mine-related subsidence. The plan is incorporated as part of the over all surface water monitoring program. Monitoring with respect to wildlife watering sources has been discussed in Appendix 7-2. The applicant will cooperate with regulatory agencies to develop and provide alternative water sources for wildlife if mine-related subsidence disturbs the present sources.

In areas where wetlands and habitats of unusually high value for fish and wildlife exist, more intensive water and subsidence monitoring may occur when deemed necessary by the permittee, Division, and/or landowner/manager. This type of monitoring has already taken place in the East Fork of Box Canyon in the Pines Tract area and is described in detail in Chapter 5 Section 5.2.5.1 and Chapter 7 Section 7.3.1.2. Only two short segments of Cowboy Creek are within the SITLA Muddy Tract. Both segments are located on the eastern portion of the tract. One segment is located in the northeast 1/4 of Section 7, T21 S, R 5 E and the other is in the eastern 1/4 of Section 5 Section 7, T 21 S, R 5 E. Both of these segments of stream are perennial and contain riparian vegetation in the channel bottom and on the banks of the channel. Additionally, there are several low flow springs within the SITLA Muddy Tract supporting riparian vegetation. The locations of these springs are identified on Plate 7-3. The riparian vegetation associated with Cowboy Creek and the springs is identified on Plate 3-1.

As discussed in the SITLA Muddy Tract PHC (Appendix 7-20), springs in the area occur within the North Horn and Price River Formations. The springs typically occur on the down gradient end of a perched aquifer where the beds containing the water are truncated by surface topography. Most of the springs occur in areas where overburden depths are approximately 1500 feet or greater. Sufco has undermined a few springs where the cover was greater than 800 feet, most of them occurring in the East Fork of Box Canyon. A few of the springs that discharged at or near the Blackhawk Formation - Castlegate Sandstone contact moved down-gradient. The remainder that discharge from the Castlegate Sandstone where the overburden is greater than 800 feet do not appear to have been significantly impacted by subsidence (PHC Appendix 7- 20 and personal communication with Erik Petersen of Petersen Hydrologic, Inc., Lehi, Utah, October 2005). Based on this experience, Sufco believes undermining the springs supporting associated riparian vegetation in the SITLA Muddy Tract will not significantly impact the vegetation.

Sufco has undermined a portion of the East Fork of Box Canyon where the flow is perennial. In the segment of the stream supported the Blackhawk Formation, subsidence related cracking of the brittle sandstone and silty sandstone beds did result in a temporary diversion of surface water into the subsurface. However, it was observed the water resurfaced down-gradient where the channel down cut through the brittle sandstone layers and encountered more plastic siltstones and shales. Mine personnel successfully repaired the channel floor with bentonite and native soils and restored the flow to the surface. Subsequent spring runoff also appears to have aided in natural repairing of the channel floor. Initial annual monitoring of the vegetation in the lower East Fork of the Box Canyon, begun in late 2003 and early 2004, has indicated the riparian vegetation adjacent to the stream channel does not appear to have been significantly impacted by subsidence.

Based on the experience to date (Fall 2005) of undermining the East Fork of Box Canyon, subsidence of the short segments of Cowboy Creek present in the SITLA Muddy tract is not anticipated to adversely impact the perennial vegetation associated with the creek. The overburden between the coal seam to be mined and the stream channel in the tract is between 1100 and 1600 feet. The underlying formations contain rock types that would be expected to easily heal surface cracks that form beneath the stream channel. Additionally, the alluvium within the stream channel supporting riparian vegetation is derived from the fine-grained rocks of the Price River and North Horn formations. This alluvium is expected to naturally readily fill fractures that may occur in the channel substrate thus limiting the loss of flow, if any, supporting the riparian vegetation.

Though not anticipated, short segments of Cowboy Creek could be subsided in the SITLA Muddy Tract. If this is anticipated to occur, Sufco, with the approval of the Division and concurrence of the Forest, will instigate a vegetation monitoring and mitigation plan similar to the plan implemented prior to the undermining of the East Fork of Box Canyon. If mitigation of surface cracks is required, methods similar to those proposed and implemented in the East Fork of Box Canyon as described in Chapter 5 Section 5.2.5.1 and Chapter 7 Section 7.3.1.8 will be used.

The monitoring and mitigation plan for undermining the South Fork of Quitchupah 2R2S Block "A" and 3R2S Block "B" is located in Appendix 3-14. Appendix 3-14 contains a Threatened, Endangered and Sensitive survey prepared by Mt. Nebo Scientific and an assessment of the macroinvertebrates in the

South Fork of Quitchupah Creek. The macroinvertebrate assessment was prepared by Dennis K. Shiozawa, Ph.D., which contains the results of a series of benthic samples taken to determine the diversity of the invertebrate community in the South Fork of Quitchupah Creek. In 2016 a final monitoring report for the the upper reaches (sites Q01 - Q09) of the riparian plant community was compiled for of the South Fork of Quitchupah Creek. The report summarizes the data gathered from 2012 thru 2015. The riparian vegetation sample stations in the South Fork were chosen by a team of experts from various agencies (see methods section within the reports). The stations included both control and sampling sites, one being outside the zone of subsidence and the other being within. It should be noted that one control spring area was impacted in the Fall of 2015, it appears that the spring had been dug out to create water for cattle, consequently the spring consists of a 6 foot diameter pool with almost no riparian vegetation and muddy banks. A second impact to the area was a control burn by the Forest Service on the slopes adjacent to the creek also in 2015, due to the burn and verbal communications with the Division it was decided to end the sampling in 2015 in the upper reaches.

Sites Q10S and Q11C will continue to be monitored through 2016. An addendum to the Riparian Vegetation Monitoring Table is included in Appendix 3-14 as are the riparian vegetation monitoring reports for 2012 thru 2015.

The applicant will request that future power lines on the SUFCO Mine site be constructed per OSM and UDOGM regulations or with alternative guidelines approved by the regulatory authority. Additional information referencing power lines is located in Section 3.5.8.5.

Efforts will be taken to regulate the use of pesticides when needed. Before a pesticide is used, the type and concentration will be approved by the Regulatory Authority.

3.40 Reclamation Plan

The Reclamation Plan will include the seed mix and rate of seedlings per acre as well as stocking rates for shrub plantings, planting techniques, fertilization methods and amount and frequency of application. The fish (see Section 3.2.2) and wildlife plan for the permit area is outlined in Section 3.4.2.

3.4.1 Revegetation

The reclamation plan for final revegetation is included in this section for all lands disturbed by coal mining and reclamation operations.

The short-term goal of this revegetation plan is the immediate stabilization of the disturbed sites through erosion control. This objective will be achieved through controlled grading practices, proper seedbed preparation to encourage rapid plant establishment, inclusion of rapidly establishing species in the seed mixture to be planted and mulch applications.

The long-term goals are to establish useful, productive range and wildlife habitat. These goals will be attained through the selection and placement of desirable and productive plant species, and a commitment to monitor and maintain revegetated areas throughout the bond liability period.

3.4.1.1 Schedule and Timetable

The reclamation timetable and schedule is outlined in Figure 5-2.

The planting of seeds and seedlings will be undertaken at the most feasible time following disturbance activities. Planting will begin after the plant growth medium has been replaced. Grasses and forbs will be tentatively planned for planting in May or early June; shrubs and seedlings in late August through early October.

3.4.1.2 Descriptions

Species and Amounts of Seed. All revegetated areas will be planted with this standard seed mix:

General Pinyon-Juniper Seed Mixture for the SUFCO Mine

Scientific Name	Common Name	Rate PLS/Ac	No. Seeds Per Ft^2
TREE & SHRUBS			
Amalanchier utahensis	Serviceberry	4.00	2.37
Artemisia tridentata	Big sagebrush	0.10	5.91
Atriplex canescens	Fourwing saltbush	2.00	2.53
Chrysothamnus nauseosus	Rubber rabbitbrush	0.30	2.75
Rosa woodsii	Wood's Rose	1.00	1.04
FORBS			
Achillea millefolium	Yarrow	0.05	3.18
Hedysarum boreale	Northern sweetvetch	4.00	3.09
Linum lewisii	Blue flax	1.00	6.38
Penstemon eatonii	Eaton penstemon	0.50	6.89
Penstemon palmeri	Palmer penstemon	0.50	7.00
GRASSES			
Bromus carinatus	Mountain brome	2.00	4.59
Elymus cinereus	Gt. Basin wildrye	2.00	4.36
Elymus smithii	Western wheatgrass	2.00	5.79
Elymus spicatus	Bluebunch wheatgrass	2.00	6.43
Elymus trachycaulus	Slender wheatgrass	1.50	5.51
Stipa hymenoides	Indian ricegrass	1.50	6.47
TOTALS		24.45	74.29
* Elymus salinus should be added if commercially available. ** Rates based on broadcast seeding.			

Note: seed amounts are pure live seed per acre

Revegetation of the mine portal and sedimentation pond area is to include the planting of 500 seedling shrubs and tree seedlings per acre, as listed below:

Shrubs and Trees Seedlings:

Bitterbrush 20%
Utah Serviceberry (15%)
Curlleaf mountain mahogany (15%)
Sagebrush 20%
Birch-leaf mountain mahogany (15%)
Woods Rose 15%

The bitterbrush seedlings could possibly be impacted by grazing deer during the first year following planting. If so, the seedlings will be replaced with another brush species.

The breakout areas (remote portals) will be reclaimed using the standard seed mix. Seeding will be done by broadcasting. Mulch and fertilization will be applied at the rates listed below under Mulching Techniques.

The riparian area of the Link Canyon Mine portals will be revegetated by planting the following seedlings:

Willow (Salix spp.) 50%
Red Osier Dogwood 20 %
Woods Rose 10%
Alder 10%
River Birch 10%

Willows intermixed with the remainder of the seedlings will be planted adjacent to the reclaimed channel and within the protective riprap. Willow cuttings from existing plants in the drainage will be cut and planted early in the first spring following reclamation construction activities. The slopes away from the channel will be reseeded with the standard seed mix at prescribed rates of application where coverage consists of at least 50 to 100 seeds per square foot. The seed mix for the Link Canyon Portal will not include alfalfa seed. Horsetail and clematis occur naturally in the area and will be allowed to invade the reclaimed area. Plugs of existing sedges in the eastern portal area will be obtained and transplanted to the reclaimed western portal.

Reclamation of the portal access road and portal area will include transplanting Creeping Oregon Grape. Creeping Oregon Grape will be transplanted to the topsoil pile during site construction and it is anticipated a portion of these plants will be used during reclamation of the access road.

Method Used for Planting and Seeding. The entire disturbed area will be revegetated using various seeding methods such as hydroseeding, broadcasting or drilling. The best available economically feasible technology will be used at the time of seeding. The tree and shrub seedlings will be planted in clumps to maximize edge effect and provide more adequate cover for wildlife. At least five clumps per acre (consisting of 100 seedlings per clump) will be planted at intervals ensuring that 35 to 50 percent of each acre is covered.

Mulching Techniques. The mixture and application rate will be:

2000 lbs. of mulch per acre
100 lbs. of nitrogen per acre
100 lbs. of phosphorus per acre

The slopes and overfill areas will involve scarification and/or construction of small terraces on the slopes. The prepared slope will tend to hold moisture and to allow for places where plants can grow.

If hydro-seeding is used, first seed, tackifier and wood fiber mulch (400 lbs/acre) will be mixed in a water slurry and applied. The mulch acts as a buffer to protect the seed from damage while spraying and as a visual indicator to verify the area covered. Next, fertilizer, tackifier, and wood fiber mulch (2000 lbs/acre) will be mixed in a water slurry and applied. The seedlings of shrubs and trees will be placed through the hydro-mulch material.

The pond area should be reclaimed using similar methodology at the conclusion of the mining operation. See Section 3.5.5 for additional discussion.

Irrigation, Pest and Disease Control. Subsequent to treatment, both hand set plantings and hydromulch applications may be given supplemental irrigation, as needed, until plants are well established. No persistent pesticides will be used by the Applicant in the mine area unless previously approved by the UDOGM.

The Link Canyon Portal reclaimed area will be fenced with three-strand barb wire to keep grazing livestock out of the reseeded and reclaimed area.

Measures Proposed for Revegetation Success. Success of revegetation and stabilization of the portal yard and overfill areas will be evaluated during the middle of each growing season, when cover and composition studies are most feasible. The same statistical methods and sample adequacy levels used in establishing the reference areas will be used in monitoring percent cover and composition of revegetation attempts in disturbed areas in as much as possible. The Applicant will comply with the statistical confidence method required in R645-301-356.120. Erosion pins will be placed on slopes at the time of reseeding operations during final reclamation. A table of random numbers will be used to determine pin placement. Measurement of erosion pins will help determine revegetation success in holding soil and stabilizing slopes.

See Appendix 2-2 page 5 through 7 for the statistical methods and sample adequacy levels used to establish the reference areas.

3.4.1.3 Greenhouse Studies, Field Trials or Other Equivalent Studies

If the UDOGM requires additional testing 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.

A field trial is to be established by Spring 1994 on the east side of the disturbed area in the vicinity of cross section C-C. The plot will be approximately .20 acres in size. Most of this slope will not be redisturbed during final reclamation and is similar to those that will be encountered in final reclamation.

The site will first be roughened by hand raking or some other method to help prepare the seed bed. The area will be broadcast seeded with the approved seed mix and recommended available fertilizer of 16 pounds nitrogen, 32 pounds phosphorus and 32 pounds potassium per acre. The seed and fertilizer will be hand raked into the prepared soil seed bed. The area will be mulched with noxious weed-free straw or hay at the minimum rate of 2,000 lbs. per acre. The straw will be anchored by hand with shovels and anchored with a plastic mesh. The plastic mesh will be anchored with wire staples. The area will then be planted with the approved available shrub seedlings. The percentage of shrub seedlings may vary due to availability, however, the area will be planted with a minimum density of 500 seedlings per acre.

3.4.2 Fish and Wildlife

The fish (see Section 3.2.2) and wildlife plan is a set of specifications and procedure to avoid potential adverse impact to wildlife and their habitat. Revegetation to sustain and improve wildlife habitat will be the primary concern of the applicant following the termination of mining operations. The plan is consistent with Sections 3.30 and 3.5.8.

3.4.2.1 Enhancement Measures

Range improvements within the lease area include 12 stock ponds, 1 water trough, several miles of range fences, approximately 1,000 acres of sagebrush burning and spraying and approximately 600 acres of reseeding (USDA, 1988). A guzzler has been added to the area recently to provide a water source for wildlife. The guzzler is protected from livestock use (See Plate 3-3 for guzzler location).

3.4.2.2 Plants Used for Wildlife Habitat

The plant species in the reclamation seed mix are consistent with those presently grown in the

permit area (excluding yellow clover which is an introduced species). Section 3.4.1.2 contains the proposed reclamation seed and shrub mix.

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 as part of the planting surface preparation to enhance the reclaimed area for wildlife habit. Rock and brush piles will be constructed to make artificial habitat. Reshaping of the disturbed area will simulate the surrounding topography. See Section 3.4.1 for additional discussion.

Ability to Support and Enhance. The plant species have the ability to support and enhance the fish or wildlife habitat after the release of the performance bonds. Shrubs will be planted in clumps of no more than 1,000 per acre.

3.4.2.3 Cropland

Cropland is not a postmining land use.

3.4.2.4 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.

3.50 Performance Standards

3.5.1 General Requirements

The Applicant commits to conduct all operations in accordance with the plans submitted in Sections R645-301-330 through R645-301-340 of the permit application.

3.5.2 Contemporaneous Reclamation

Reclamation of the pre-SMCRA coal slide areas south of the permit area as shown on Plate 5-2B was completed in 1981 in accordance with a USFS and OSM-approved plan.

The Applicant will revegetate areas for interim periods with grasses and forbs. An example of this type of interim reclamation would be an area in which erosion control is needed for the interim period before redisturbance. Sparse interim vegetation will aid in preventing soil erosion. 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).

Permit conditions will dictate the reclamation measures to be performed on land disturbed by such activities as exploratory drilling.

3.5.3 Revegetation: General Requirements

A vegetative cover will be established on all reclaimed areas to allow for postmining land use (primarily wildlife habitat). Water areas and surface areas of roads will not be revegetated. The vegetative cover will be in accordance with the approved permit and reclamation plan. All species of vegetation to be used in reclamation activities, whether planted by seed or seedlings, shall be approved by the appropriate governmental\agencies.

3.5.3.1 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 quick establishment and spreading.

Native Species. The vegetative mixture will be comprised of species native to the area, capable of achieving postmining land use an approved by the UDOGM. Only native species are recommended for revegetation of the mine portal and pond areas. Diversity of species should allow ultimate utilization of plants by wildlife and by domestic livestock. Both mine portal and pond areas are regarded as harsh environments and might require exceptional methodology before successful revegetation is realized.

The revegetative species will be purchased from suppliers who will certify their percentages of purity, germination, hard seed, and percentages of maximum weed seed contents.

Extent of Cover. The vegetative cover will be at least equal in extent to the natural vegetation of the reference areas.

Stabilizing. The vegetative cover mixture is capable of stabilizing the soil surface from erosion.

3.5.3.2 Reestablished Plant Species

Compatible. The reestablished plant species have been selected to insure their compatible with the approved postmining 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 mix suggested for revegetation contains plants native to the area and compatible with the plants and animals species of the permit area.

Federal and Utah Laws or Regulations. The seed mixture purchased to revegetate the mine area will contain no poisonous or noxious plant. No species will be introduced in the area without being approved by the UDOGM.

3.5.3.3 Vegetative Exception

The applicant does not require vegetative exception at this time.

3.5.3.4 Cropland

The permit area contains no land designated as cropland for postmining land use.

3.5.4 Revegetation: Timing

The applicant will follow the recommended guidelines for revegetation as discussed in Section 3.4.1.1.

3.5.5 Revegetation: Mulching and Other Soil Stabilizing Practices

Hydromulching will be used on slopes 1.5:1 or steeper and will consist of chopped straw or fiber mixed with water and machine blown at the rate of 2,000 lbs/acre mulch mats may also be use on these steep slopes. Mulching and revegetation will not be attempted on sheer rock outcrops.

On slopes flatter than 1.5:1 mulch will be applied at the rate of 2,000 lbs/acre. Different mulches such as straw, hay and wood fiber may be used.

Suitable mulch and other soil stabilizing practices will be used on all areas that have been regraded and covered by topsoil or topsoil substitutes. The slopes will be scarified or small terraces will be constructed.

Slopes 1.5:1 or steeper will not hold topsoil; therefore, these slopes will be revegetated without the application of topsoil. Seeds for grasses and forbs will be incorporated in a water slurry with a tackifier and mulch material (400 lbs/acre) and applied. Fertilizer and the hydromulch materials (2000 lbs/acre) will then be applied as a separate application. The shrub and tree seedlings will be placed through the hydromulch material.

The Applicant will exercise care to guard against erosion during and after application of topsoil and will employ the necessary measures to ensure the stability of topsoil on graded slopes.

Reclaimed slopes in the area of the Muddy Creek Breakout will be protected from erosion by the application of an erosion mat, such as an excelsior mat, stapled in place. The mat will be placed after the application of seed and fertilizer. Because of the limited area and steep slope associated with the breakout, the seed and fertilizer will be applied at the same rate as specified for hydromulching and hydroseeding.

3.5.6 Revegetation: Standards for Success

The standards for revegetation success are detailed in Section 3.4.1.2 and Appendix 2-2.

3.5.6.1 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 3.5.3.

Sampling Techniques. The applicant will comply with the standards for success, 2statistically valid sampling techniques for measuring success, and the approved methods outlined in the UDOGM's currently approved "Vegetation Information Guidelines, Appendix A" (Appendix 3-6 contains guidelines that were in place).

Standards for Success. The sampling techniques for success will use a 90 percent statistical confidence interval as required by R645-301-356.120. The standards for success will include criteria representative of unmined lands in the area of the permit. Areas not achieving 90 percent of the cover in adjacent areas with similar vegetation will be reevaluated and augmentation reclamation measures will be made to successfully vegetate those areas.

3.5.6.2 Standards for Success

Standards of success will be applied in accordance with the approved postmining land use as described in this section.

Grazing Land or Pasture Land. The ground cover and production of living plants on the revegetated area will be at least equal to the reference area.

Cropland. There is no area designated as cropland within the permit area.

Fish and Wildlife Habitat. The success of revegetation for fish and wildlife habitat will be determined on the basis of tree and shrub stocking and vegetative ground cover. Minimum stocking and planting arrangements will be specified by the UDOGM on the basis of local and regional conditions. Trees and shrubs will be healthy and at least 80 percent will be in place at least eight growing seasons after reclamation to allow for the bond release. Ground cover success 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 Areas. The SUFCO Mine has been in operation since 1941. Since 1977, interim revegetation has been done but there is no record of revegetation being done prior to 1977. The applicant will restore the vegetative ground cover to that of the surrounding area and the ground cover will be adequate to control erosion.

The Link Canyon Portals will be constructed in an area that was disturbed by pre-SMCRA mining activities. The portals in this area were closed in the 1950's. Two reference areas, a Pinyon-Juniper area and a riparian area, specific to these portals were created in July 2002. Success standards for the Link Canyon Portal area will be based on a comparison between the reference areas specific to the Link Canyon Portals and the reclaimed area applying the required statistical confidence method described above.

3.5.6.3 Siltation Structure Maintenance

Siltation structures will be maintained until removal is authorized by the UDOGM and the disturbed areas has been stabilized and revegetated. The structures will be removed not sooner than two years after the last augmented seeding. For additional details on siltation structures, see Section 5.4.2.

3.5.6.4 Removal of Siltation Structures

The land on which siltation structures are located will be revegetated in accordance with the reclamation plan Sections R645-301-353 and R645-301-357.

3.5.7 Revegetation: Extended Responsibility Period

The applicant will be responsible for the success of revegetation for a period of ten years following seeding, fertilization and irrigation of the reclaimed mine area.

3.5.7.1 Extended Period Begins

The period of extended responsibility will begin the year after the reseeding, fertilization, and irrigation have been completed.

3.5.7.2 Vegetative Parameters

Vegetation parameters will equal or exceed the approved success standard during the last two years of the responsibility period. The success standards are outlined in Sections 3.5.6.1 and 3.5.6.2 of this application.

3.5.7.3 Husbandry Practices

The Applicant will comply with UDOGM approved husbandry practices which will be normal conservation practices within the region of the mine. These practices may include disease, pest, and vermin control; and any pruning, reseeding and transplanting required.

3.5.8 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 3.3.3. The company will continue to educate their employees and habitat users about wildlife needs and their importance.

The intermittent flow of streams within the lease area does not support a population of game fish; therefore, there are no fisheries within the permit area to protect.

3.5.8.1 Existence of Endangered or Threatened Species

Coal mining will not be conducted where its operation might jeopardize the existence of any endangered or threatened species. The mining of coal will not result in the destruction or adverse modification of these specie's critical habitat.

Any state or federally listed endangered or threatened specie will be reported to the UDOGM upon its discovery. Mining operations will proceed in accordance with the UDOGM's stipulations. These stipulations also apply to reclamation operation at the SUFCO Mine.

Discussion of threatened and endangered species are presented in the following reports: WIL, pages 8 and 44, Appendix 3-3: RAP, pages 8-9, Appendix 3-4: and AQU, page 6, Appendix 3-5. A more current listing of threatened and endangered species are included in this M&RP as Table 3-1 and Table 3-2.

3.5.8.2 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 promptly report any golden or bald eagle nests found within the permit boundaries and will proceed with operations in accordance with the UDOGM's stipulations.

3.5.8.3 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.

3.5.8.4 Replacement of Wetland and Riparian Vegetation

No riparian habitat has been disturbed.

3.5.8.5 Manmade Wildlife Protection Measure

Electric Power Lines. All power lines within the SUFCO Mine permit area were modified during the summer of 1981 to comply with the guidelines of REA Bulletin 61-10, "Power Line Contacts by Eagles and Other Large Birds". Various correspondence regarding the Applicant's modification of power lines is presented in Appendix 3-7. The locations of mine site power poles are shown on Plate 5-5.

Potential Barriers. The mine has been operating approximately 55 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. Fences or other appropriate methods will be used to exclude wildlife from ponds containing hazardous concentrations of toxic-forming materials. However, at this time the applicant has no ponds containing hazardous concentrations of toxic-forming materials.

REFERENCES:

Blumer, Ralph J., 1979. Environmental Analysis, pp 25-26.

Hennessy, S. P., 1978. Ecological relationships of accipters in northern Utah -- with special emphasis on the effects of human disturbance. MS thesis, unpbl., Utah State Univ., p 66.

USDA, Forest Service, Intermountain Region 1988. Environmental Assessment for SUFCO Mine Coal Lease Application U-63214 Quitchupah Tract.

Utah Division of Wildlife Resources, Department of Natural Resources, 1991. Utah Big Game Annual Report 1991. Publication 91-12.

U.S. Department of the Interior, Final Supplemental Impact Statement for Leasing and Underground Mining of the Greens Hollow Federal Coal Lease Tract UTU-84102, Sanpete and Sevier Counties, Utah, February 2015

APPENDIX 3-4

Raptor and General Avifauna Studies

Add to Confidential Folder

Greens Hollow Tract

Biological Survey 2013

CONFIDENTIAL

TETRA TECH

[illegible] East South Temple, Suite [illegible]
Salt Lake City Utah 84111
Tel 801 364 1064 Fax 801 364-2021
www.tetratech.com

Technical Memorandum

To:	Mark Bunnell	**From:**	Tetra Tech: Mike Egan, Project Manager Justin DeCaro, Wildlife Biologist James Hart, Wildlife Biologist
Company:	Ark Land- SUFCO Mine 597 South SR 24 Salina, UT 84654		
CC:	Kreig Rasmussen, USDA Forest Service	**Date:**	06/10/2013
Re:	Biological Surveys for the Proposed 2013 Exploration Drill Holes	**Project:**	114-520141

Mr. Bunnell:

On behalf of Ark Land Company (Ark Land), Tetra Tech Inc. (Tetra Tech) conducted biological surveys on May 14 and 30, 2013 in support of the 2013 SUFCO Mine exploration project near Quitchupah Canyon. The project is located on land administered by the U.S. Department of Agriculture, Forest Service (USFS), Fishlake National Forest (FLNF) and Manti-La Sal National Forest within Sections 13, 14, 15, 23 and 24, Township 21 South, Range 4 East. The project features consists of eight drill holes; temporary water tanks and pumps; waterlines; helicopter flight paths; and a landing zone/staging area (**Figure 1**).

On May 10, 2013 Tetra Tech biologist Justin DeCaro consulted Mr. Kreig Rasmussen of the USFS for specific survey requirements for this project. In particular, Mr. Rasmussen requested that Tetra Tech biologists' thoroughly survey suitable greater sage-grouse (*Centrocercus urophasianus*) habitat around the drill holes. He stated that there is suitable habitat for the sage-grouse on the north end of the FLNF along the boundary with the Manti-La Sal National Forest, but that the USFS has not located any sage-grouse or identified signs that sage-grouse are using the area. The biological surveys conducted for this project include:

- A two-visit northern goshawk (*Accipiter gentilis)* broadcast vocalization survey
- Raptor nest survey
- Visual encounter surveys for:
    1. Greater sage-grouse
    2. Pygmy rabbit (*Brachylagus idahoensis*)
    3. Western boreal toad (*Bufo boreas*)
    4. U.S. Fish and Wildlife Service (USFWS) federally listed plant, wildlife, and aquatic species for Sevier County
    5. Other USFS Sensitive Species
    6. USFS Management Indicator Species (MIS)
    7. Utah Division of Natural Resources (UDWR) Species of Concern (SPC) that have potential to occur in Sevier County
    8. Migratory bird species

SURVEY METHODS

Northern Goshawk Broadcast Vocalization Surveys

Northern goshawk broadcast vocalization surveys were conducted following the USFS protocol (Woodbridge and Hargis 2006). At each calling station, a northern goshawk alarm call was broadcast for 10 seconds, followed by 30 seconds of attentive listening and watching. Biologists would then repeat this sequence two more times, with 120 degrees of rotation between each call. Calls were broadcast on calm days no earlier than one-half hour before sunrise and no later than one-half hour after sunset.

The survey area was a 0.5-mile buffer around all project features associated with the exploration area. Survey calling points were located within suitable habitat along flight lines and at each project feature, at least 200 meters apart. The area was surveyed two times, with visits 17 days apart. Photos were taken of each drill site to document habitat conditions.

Raptor Nest Surveys

Raptor nest surveys were conducted following guidance from the 2010 State of Utah Department of Natural Resources, Division of Oil, Gas, and Mining *Raptor Survey Guidelines* (DOGM 2010). All suitable nesting habitat identified in the exploration area and the accompanying 0.5-mile buffer were surveyed (including stands of conifer, aspen (*Populus tremuloides*) or other trees; cliff areas; and historic nesting sites). All previously known nests in the survey area were visited during the surveys to determine nesting activity and nest condition. There are two previously known raptor nests that exist within the survey area in the North Fork of Quitchupah Canyon (**Figure 1**): a red-tailed hawk (*Buteo jamaicensis*) nest (#971) and a prairie falcon (*Falco mexicanus*) eyrie (#792). The locations of any new raptor nests encountered during the surveys were recorded. Biologists also recorded any individual raptors that were observed while walking and driving throughout the project area. Spotting scopes and binoculars were used to identify raptor species, verify the presence of nests (historic and new), and determine nest condition and activity.

Visual Encounter Surveys

Surveys were conducted throughout the exploration area and the accompanying 0.5-mile buffer for the following:

- Suitable sagebrush habitat was surveyed for visual presence and signs of greater sage-grouse including scat and feathers.
- Suitable sagebrush habitat was also surveyed for visual presence and signs of pygmy rabbits including scat and burrows.
- All wetlands occurring in the survey area were surveyed for western boreal toads by slowly walking around the perimeter of the feature.
- Visual encounter surveys for USFWS federally listed species, other USFS Sensitive, USFS MIS's, UDWR SPC, all migratory bird species, and any other incidental species were also conducted in conjunction with all of the above surveys. The locations of any of these species encountered during the survey were recorded.

RESULTS: HABITAT ASSESSMENT

Drill Sites

- Drill Site A-13: Located on a flat area on a ridge. Vegetation is dominated by grass, sagebrush (*Artemisia tridentata*), limber pine (*Pinus flexilis*), mountain mahogany (*Cercocarpus ledifolius*), and Gambel oak (*Quercus gambelii*)
- Drill Site B-13: Located on a gently sloping hillside. Vegetation consists of serviceberry (*Amelanchier alnifolia*), Gambel oak, sagebrush, limber pine, and mountain mahogany.
- Drill Site C-13: Located on a moderately steep hillside. Vegetation consists of limber pine, sagebrush, mountain mahogany, subalpine fir (*Abies lasiocarpa)*, and service berry.
- Drill Site D-13: Located on gently sloping hillside. Vegetation consists of mountain mahogany, aspen, subalpine fir, Gambel oak, sagebrush, and mountain mahogany.
- Drill Site E-13: Located on a north aspect. Site contains a fair amount of aspen. Also limber pine, mountain mahogany, snowberry (*Symphoricarpos albus*), sagebrush, serviceberry, and rabbitbrush (*Chrysothamnus vicidiflorus*)
- Drill Site F-13: Located on an open ridgeline. Vegetation consists mostly of shrub (sagebrush, mahogany, and serviceberry) and grass mix, with scattered limber pine, aspen, and Douglas fir (*Pseudotsuga menziesii*).
- Drill Site G-13: Located in a canyon with two small stands of aspen (*Populus tremuloides*) (roughly 50 trees). The general landscape is dominated by sagebrush and mountain mahogany (*C. ledifolius,* and *C. montanus*) with scattered limber pines.
- Drill Site H-13: Located on a north-east aspect. Vegetation consists of mixed conifer, including Douglas fir, aspen, spruce (*Picea engelmannii*), snowberry, and sagebrush.

RESULTS: SURVEY RESULTS

The weather on May 14, 2013 was around 65 degrees Fahrenheit, with partly cloudy skies, and variable winds of five to eight miles per hour (mph). Weather during the second visit on May 30, 2013 was approximately 60 degrees Fahrenheit, with cloudy skies, and variable winds of zero to three mph.

Northern Goshawk Survey Results

The ability to detect northern goshawk or other raptor nests was excellent because the aspen trees had not leafed out yet. No northern goshawks or northern goshawk nests were detected within the survey area. The majority of the habitat in the survey area is not suitable for goshawk nesting due to the lack of expansive, mature stands of timber. The most suitable northern goshawk habitat within the 2013 exploration area is the mixed conifer stands in the area north and northwest of drill holes C-13, D-13, and H-13. All northern aspects within the survey area contain some mixed conifer forest.

Raptor Nest Survey Results

No new raptor nests were identified during the survey. The historic red-tailed hawk nest (#971) was not detected. It appears that this nest either no longer exists (it was not detected in surveys conducted in 2012 either), or is not visible from the ground. There was also no evidence of recent use of the prairie falcon eyrie (#792). However, a prairie falcon was observed soaring to the east of the historic nest area.

An American kestrel (*Falco sparverius*) and a pair of red-tailed hawks were the only raptors observed within the survey area. The red-tailed hawk pair was observed approximately 200 meters south of A-13. They were not exhibiting territorial behavior, and no nest was detected. A prairie falcon was observed outside the survey area, as described above.

Visual Encounter Survey Results

No greater sage-grouse, pygmy rabbit, or boreal toad or their sign were observed within the project area. A wetland located approximately 300 meters north of drill hole C-13 was surveyed for boreal toad, but none were detected. A photo of the wetland is attached to this report.

No USFWS threatened, endangered, candidate, or proposed species; other USFS Sensitive; other USFS MIS's; or UDWR SPC species were documented within the project area. **Table 1** lists migratory bird species observed within the project area during the May 2013 surveys. Other wildlife species observed during the surveys include mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*), and yellow-bellied marmot (*Marmota flaviventris*).

If you have any questions regarding this memo, please contact Mike Egan at 801-364-1064 extension 203.

Sincerely,
Tetra Tech, Inc.

Michael M. Egan

Michael Egan
Sr. Project Manager

Attachments: **Figure 1**
Table 1
Field Photo

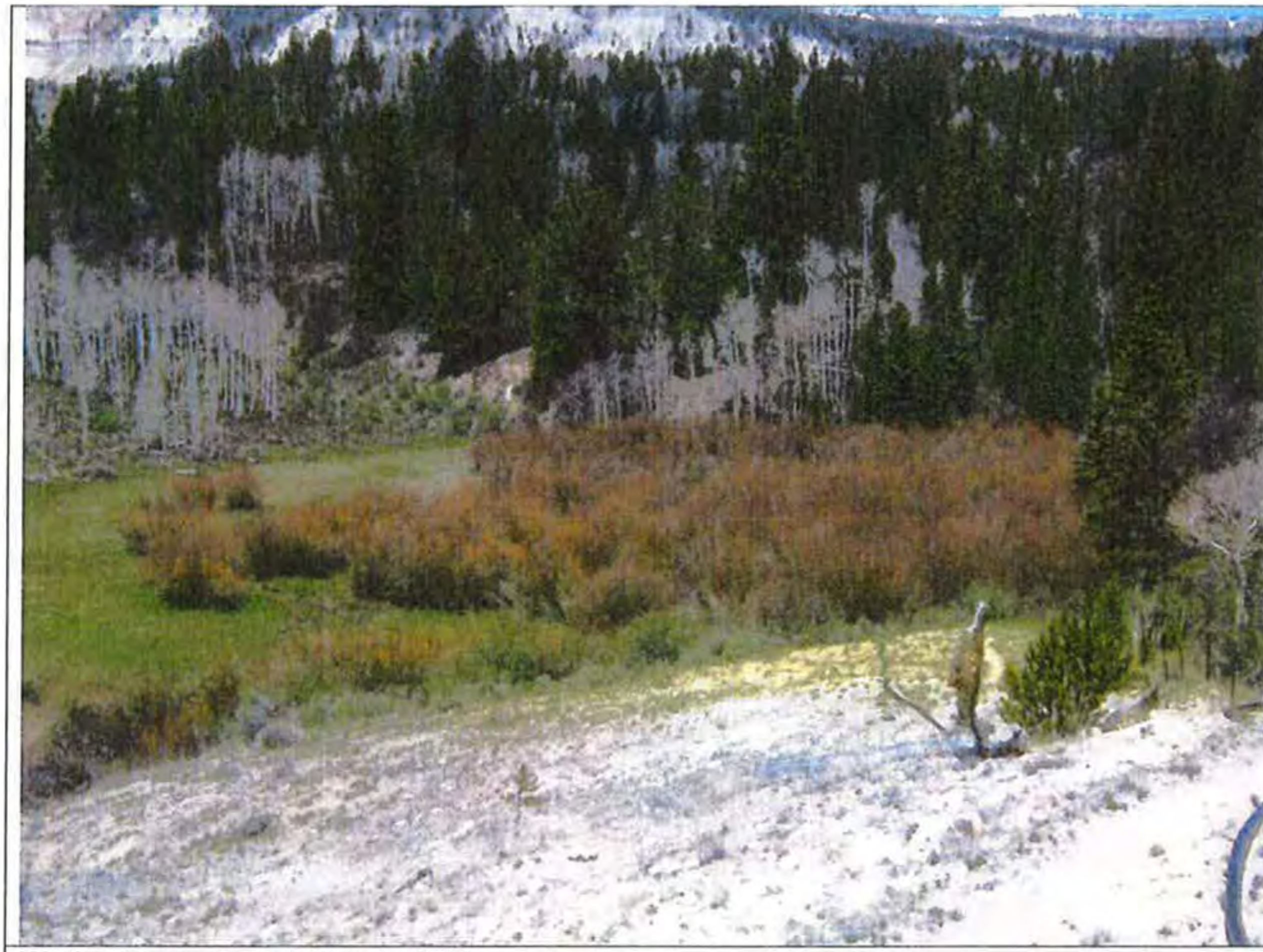
REFERENCES

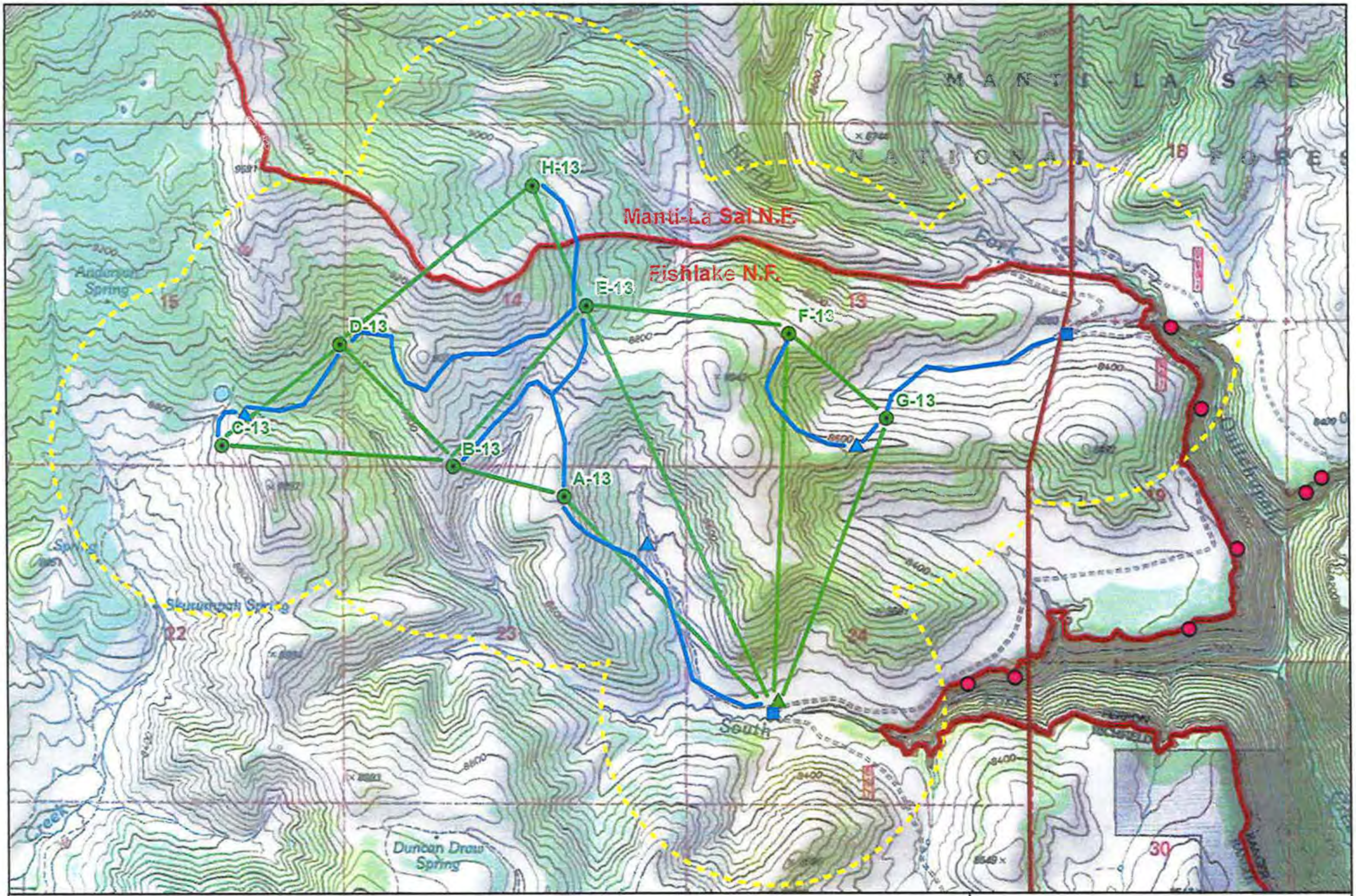
Division of Oil, Gas and Mining (DOGM). 2010. *Raptor Survey Guidelines.* March, 2010. 23 pp.

Woodbridge, B. and C.D. Hargis. 2006. *Northern Goshawk Inventory and Monitoring Technical Guide*. Gen. Tech. Rep. WO-71. Washington, DC: U.S. Department of Agriculture, Forest Service. 80 pp.

Table 1: Migratory Bird Species Observed Within the SUFCO 2013 Exploration Drilling Project Area, May 2013

American Kestrel (*Falco sparverius*)
American Robin *(Turdus migratorius)*
Black-billed Magpie (*Pica hudsonia*)
Black-capped Chickadee (*Poecile atricapillus*)
Black-headed Grosbeak (*Pheucticus melanocephalus*)
Brewer's Sparrow (*Spizella breweri)*
Cassin's Finch (*Carpodacus cassinii)*
Cassin's Vireo (*Vireo cassinii*)
Chipping Sparrow (*Spizella passerine)*
Clark's Nutcracker (*Nucifraga columbiana)*
Common Raven (*Corvus corax)*
Dark-eyed Junco (*Junco hyemalis*)
Dusky Flycatcher **(***Empidonax oberholseri)*
Green-tailed Towhee (*Pipilo chlorurus)*
House Wren (*Troglodytes aedon*)
MacGillivray's Warbler (*Geothlypis tolmiei*)
Mountain Bluebird (*Sialia currucoides)*
Mountain Chickadee (*Poecile gambeli*)
Northern Flicker (*Colaptes auratus)*
Orange-crowned Warbler (*Oreothlypis celata*)
Plumbeous Vireo (*Vireo plumbeus*)
Red-breasted Nuthatch (*Sitta canadensis)*
Red-naped Sapsucker (*Sphyrapicus nuchalis*)
Red-tailed Hawk (*Buteo jamaicensis*)
Ruby-crowned Kinglet (*Regulus calendula)*
Stellar's Jay (*Cyanocitta stelleri)*
Turkey Vulture (*Cathartes aura)*
Vesper Sparrow (*Pooecetes gramineus)*
Virginia's Warbler (*Oreothlypis virginiae*)
Western Wood-pewee (*Contopus sordidulus)*
Yellow-rumped Warbler (*Dendroica coronata)*
Yellow Warbler (*Setophaga petechia*)


Wetland area near drill hole C-13.



Legend

- Existing Raptor Nest
- Proposed 2013 Drill Site
- Helicopter LZ and Staging Area
- Marshmallow Tank/Pump
- Water Tank/P
- Approx. Helicopter Flight Line
- 2" to 4" HDPE Waterline
- Township Range
- Half-Mile Buffer Around Project Area
- USDA Forest Service Boundary

0 0.25 0.5 1 Miles

TETRATECH

Date: 6/10/2013

Figure 1:
Biological Surveys Around 2013 Drill Hole Locations

Fishlake and Manti-La Sal National Forests, Sevier Co., U

Ark Land, SUFCO Mine

Path: R:\A-G\Arch\ ... _Ark Land Company\114-520141 - Ark Land SUFCO 2013 Exp\120- GIS\mxd\SUFCO_2013Dr...g_ForMemo.mxd

136 East South Temple Suite 910
Salt Lake City Utah 84111
Tel 801-364-1064 Fax 801-364-2021
www.tetratech.com

Technical Memorandum

To:	Vicky Miller	**From:**	Tetra Tech: Mike Egan, Project Manager Justin DeCaro, Wildlife Biologist James Hart, Wildlife Biologist
Company:	SUFCO Mine 597 South SR 24 Salina, UT 84654	**Date:**	07/23/2013
Re:	2013 Raptor Surveys	**Project:**	114-520145

Ms. Miller:

On behalf of Arch Coal's Sufco Mine (Sufco), Tetra Tech Inc. (Tetra Tech) conducted raptor surveys (raptor use and raptor nest inventories) on May 15, 16, 29, and 30, 2013 at the Sufco Mine in support of annual raptor monitoring requirements. The surveys were conducted in four areas (Area 3, Area 4, East Fork Box Canyon Area, and Waste Rock Disposal Area). **Figure 1** presents a topographical map showing the locations of each of the survey areas.

The Area 3, Area 4 and East Fork Box Canyon Area are located on land administered by the U.S. Department of Agriculture (USDA) Forest Service, Fishlake National Forest (FLNF) and Manti-La Sal National Forest (MLNF). The Waste Rock Disposal Area is located on private property surrounded by the FLNF. Area 3 and Area 4 are located within Sections 23, 24, 25 and 26, Township (T) 21 South (S), Range (R) 4 East (E); Section 30, T21S, R5E; and Section 12, T22S, R4E. The East Fork Box Canyon Area is located in Sections 3, 10, 11, and 14, T21S, R5E. The Waste Rock Disposal Area is located within Section 18, T22S, R4E (**Figure 1**).

SURVEY METHODS

Raptor Surveys

Raptor surveys were conducted following guidance from the 2010 State of Utah Department of Natural Resources, Division of Oil, Gas and Mining (DOGM) *Raptor Survey Guidelines* (DOGM 2010). All suitable nesting habitat identified in Area 3, Area 4, and the Waste Rock Disposal Area and accompanying one-mile buffer were surveyed. In addition, all suitable nesting habitat identified in the East Fork Box Canyon Area was also surveyed. All previously known nests in the survey areas were visited during the surveys to determine nesting activity. There are 25 previously known raptor nests that exist within the survey areas (**Figure 1**).

The location of any new raptor nests encountered during the surveys was recorded. Biologists also recorded any individual raptors that were observed while walking and driving throughout the survey areas. Spotting scopes and binoculars were used to identify raptor species, verify the presence of nests (historic and new), and determine nest condition and activity.

Northern Goshawk Broadcast Vocalization and Intensive Search Surveys

Northern goshawk (*Accipiter gentilis*) broadcast vocalization surveys were conducted following the Forest Service protocol (Woodbridge and Hargis 2006). At each calling station, a northern goshawk alarm call was broadcast for 10 seconds, followed by 30 seconds of attentive listening and watching. Biologists would then repeat this sequence two more times, with 120 degrees of rotation between each call. Calls were broadcast on calm days no earlier than one-half hour before sunrise and no later than one-half hour after sunset.

An intensive search during travel between each call station was also conducted. This included listening for vocalizations and looking in mature trees for potential nesting sites. Biologists also inspected the ground for white wash, prey remains and feathers. The locations of any individuals encountered during the survey were recorded. Survey calling points were located within any suitable habitat within the survey areas at least 200 meters apart. The suitable habitat within the survey areas was surveyed two times, with visits at least seven days apart.

Incidental Observations

During travel throughout the survey areas, any occurrences of special status species of flora and fauna were recorded. This included migratory bird species and FLNF and MLNF management indicator species (i.e. elk (*Cervus canadensis*) calving, mule deer (*Odocoileus hemionus*) fawning, and greater sage-grouse (*Centrocercus urophasianus*). In addition, observations of other incidental wildlife species within the survey areas were also documented.

RESULTS: HABITAT ASSESSMENT

Habitat within Area 3, Area 4, and the Waste Rock Disposal Area consists primarily of sagebrush (*Artemisia tridentata*) shrublands, mountain shrub, and small stands of conifer and aspen (*Populus tremuloides*). The Waste Rock Disposal Area contains small patches of mixed conifer and aspen, intermixed with the sagebrush and mountain brush species. The habitat in the East Fork Box Canyon Area consists primarily of ponderosa pine (*Pinus ponderosa*), aspen and mixed shrublands. The Waste Rock Disposal Area is much lower in elevation than the other survey areas.

RESULTS: SURVEY RESULTS

The weather on May 15 and 16, 2013 was around 60 degrees Fahrenheit, with partly cloudy/cloudy skies, and variable winds of zero to 10 miles per hour (mph). Weather during the second visit on May 29 and 30, 2013 was between 55 and 65 degrees Fahrenheit, with partly cloudy skies and no winds.

Raptor Survey Results

There were four active raptor nests in the 2013 survey area, of which three were new nests. The three new raptor nests (TT7_RTHA, TT8_RTHA, and TT9_RTHA) were all occupied by red-tailed hawks (*Buteo jamaicensis*). All three of the new nests were located within the one-mile buffer of the Waste Rock Disposal Area and all were on private property (**Figure 1**). Observations of these nests were made from a distance using binoculars and a spotting scope; therefore, the coordinates are estimated. According to DOGM (2010), the spatial buffer for red-tailed hawks is 0.5-mile. Only nest TT7_RTHA was within 0.5 mile of the Waste Rock Disposal

Area. All three nests were located in aspen trees (the aspen tree where TT8_RTHA was located was a snag). During the first survey, all three nests were occupied by incubating female red-tailed hawks (see attached **Field Photos**). During the second survey, these nests were checked again to determine productivity. Nest TT9_RTHA had two nestlings. Nests TT7_RTHA and TT8_RTHA still had incubating females.

Of the 25 previously known nests that were surveyed, only one golden eagle nest (305GOEA) was active. This nest is located in Convulsion Canyon within 250 feet of the Area 4 boundary. During the first survey, the nest had one nestling and during the second survey there was still one nestling that appeared to be close to fledging (see attached **Field Photos**).

Two other raptor species were observed flying through the survey areas. During the first survey, a Cooper's hawk (*Accipiter cooperii*) and a prairie falcon (*Falco mexicanus*) were observed near the Waste Rock Disposal Area. During the second survey, no other raptors were observed.

Northern Goshawk Survey Results

The ability to detect northern goshawk and other raptor nests was excellent because the aspen trees had not leafed out yet. No northern goshawks or northern goshawk nests were detected within the survey areas. The habitat in the survey areas is not optimal for goshawk nesting due to the lack of expansive, mature stands of timber. According to the Forest Service, northern goshawks are known to use the Box Canyon area in late winter/early spring, but are thought to move to higher elevations later in the season where more suitable mixed-conifer habitat exists. The Forest Service has done extensive nest searches in this area in the past, but no nests have ever been observed.

Incidental Observations

No special status species of flora and fauna, including FLNF and MLNF management indicator species (i.e., elk calving, mule deer fawning and greater sage-grouse breeding/nesting) were observed within the survey areas. One mule deer was observed during the first survey near the East Fork Box Canyon Area. **Table 1** lists migratory bird species observed within the survey areas during the May 2013 surveys.

If you have any questions regarding this memo, please contact Mike Egan at 801-364-1064 extension 203.

Sincerely,
Tetra Tech, Inc.

Michael M. Egan

Michael Egan
Sr. Project Manager

Attachments: **Figure 1**
Table 1
Field Photos

REFERENCES

Division of Oil, Gas and Mining (DOGM). 2010. *Raptor Survey Guidelines.* March, 2010. 23 pp.

Woodbridge, B. and C.D. Hargis. 2006. *Northern Goshawk Inventory and Monitoring Technical Guide.* Gen. Tech. Rep. WO-71. Washington, DC: U.S. Department of Agriculture, Forest Service. 80 pp.

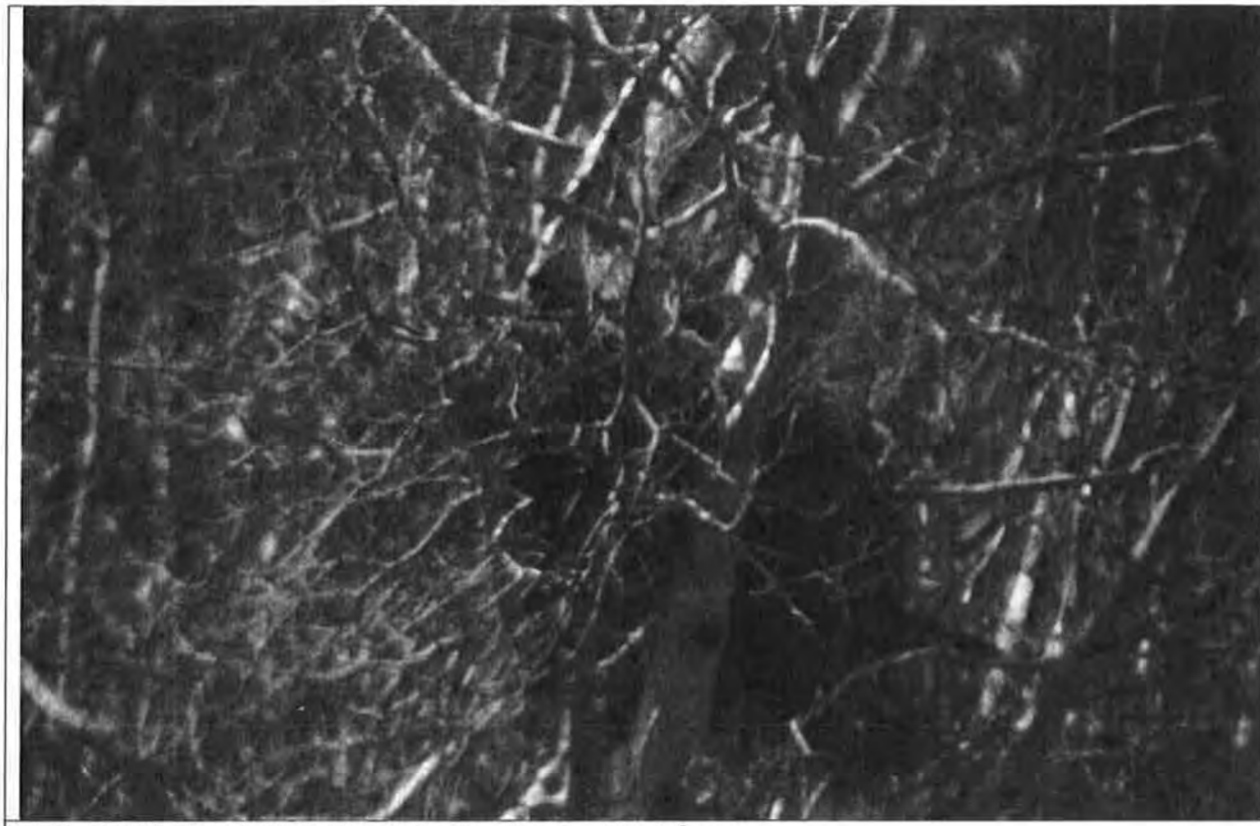
Table 1: Migratory Bird Species Observed Within the Sufco 2013 Raptor Survey Areas, May 2013

American Robin *(Turdus migratorius)*
Black-billed Magpie (*Pica hudsonia*)
Black-capped Chickadee (*Poecile atricapillus*)
Brewer's Sparrow (*Spizella breweri*)
Cassin's Finch (*Carpodacus cassinii*)
Chipping Sparrow (*Spizella passerine*)
Clark's Nutcracker (*Nucifraga columbiana*)
Common Raven (*Corvus corax*)
Cooper's Hawk (*Accipiter cooperii*)
Dark-eyed Junco (*Junco hyemalis*)
Downy Woodpecker (*Picoides pubescens*)
Dusky Flycatcher **(***Empidonax oberholseri*)
Golden Eagle (*Aquila chrysaetos*)
Hairy Woodpecker (*Picoides villosus*)
Hermit Thrush (*Catharus guttatus*)
Mountain Bluebird (*Sialia currucoides*)
Mountain Chickadee (*Poecile gambeli*)
Mourning Dove (*Zenaida macroura*)
Northern Flicker (*Colaptes auratus)*
Pine Siskin (*Spinus pinus*)
Prairie Falcon (*Falco mexicanus*)
Red-breasted Nuthatch (*Sitta canadensis*)
Red-tailed Hawk (*Buteo jamaicensis*)
Rock Wren (*Salpinctes obsoletus*)
Ruby-crowned Kinglet (*Regulus calendula)*
Stellar's Jay (*Cyanocitta stelleri*)
Townsend's Solitaire (*Myadestes townsendi*)
Violet-green Swallow (*Tachycineta thalassina*)
Western Bluebird (*Sialia mexicana*)
Western Wood-pewee (*Contopus sordidulus*)
Yellow-rumped Warbler (*Dendroica coronata*)

Field Photos

TT7_RTHA Red-tailed Hawk Active Nest – First Survey.

TT8_RTHA Red-tailed Hawk Active Nest – First Survey.



TT9_RTHA Red-tailed Hawk Active Nest – First Survey.

305 Golden Eagle Active Nest – First Survey

305 Golden Eagle Active Nest – Second Survey

Biological Survey 2014

CONFIDENTIAL

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Salt Lake City Utah 84111
Tel 801-364-1064 Fax 801-364-2021
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Technical Memorandum

To:	Mark Bunnell	**From:**	Tetra Tech:
Company:	Bowie Resource Partners LLC SUFCO Mine 597 South SR 24 Salina, UT 84654		Mike Egan, Project Manager Justin DeCaro, Wildlife Biologist
CC:	Kreig Rasmussen, USDA Forest Service	**Date:**	07/22/2014
Re:	**Addendum** - Biological Surveys for the Proposed 2014 Exploration Program	**Project:**	114-520226

Mr. Bunnell:

On behalf of Bowie Resource Partners LLC (dba Canyon Fuel Company, LLC), Tetra Tech Inc. (Tetra Tech) conducted biological surveys at an additional drill hole (S-14) in support of the 2014 SUFCO Mine proposed drilling exploration project. This report is an addendum to the original report submitted on June 20, 2014.

The additional drill hole S-14 is located on the Manti La Sal National Forest, in Section 18 Township 21 South, Range 5 East. This drill hole is near holes M-14, N-14, O-14, and P-14, and would be supported by the same staging area/landing zone located at the north fork of Quitchupah Creek (**Figure 1 (revised)**). The drill hole and a surrounding half-mile buffer was surveyed on July 20, 2014 for raptor nests. In addition, broadcast vocalization surveys were conducted for northern goshawk (*Accipter gentilis*) and visual encounter surveys were conducted for greater sage-grouse (*Centrocercus urophasianus*); pygmy rabbit (*Brachylagus idahoensis*); federally threatened, endangered, candidate or proposed species; Forest Service Sensitive and Management Indicator Species (MIS); and state listed species. Migratory birds and other wildlife observed during the survey were also documented. Methods were the same used in the previous surveys (see memo from June 20, 2014).

RESULTS

Habitat Assessment

Drill Site S-14: Located near top of a ridgeline on south/southwest facing slope. Vegetation consists of Rocky Mountain juniper, pinyon pine, Gambel oak, limber pine, serviceberry, mountain mahogany, and sagebrush.

Wildlife Survey

No northern goshawk or other raptor nests were detected during the survey. No federally threatened, endangered, candidate or proposed species were documented. No Forest Service Sensitive or MIS or state-listed species were documented.

One adult red-tailed hawk was observed soaring approximately 200m to the west of proposed drill site.

The following migratory birds were recorded during the survey:

- Clark's Nutcracker
- Mountain Bluebird
- Black-billed Magpie
- Spotted Towhee
- Green-tailed Towhee
- Black-capped chickadee
- Chipping Sparrow
- Dark-eyed Junco

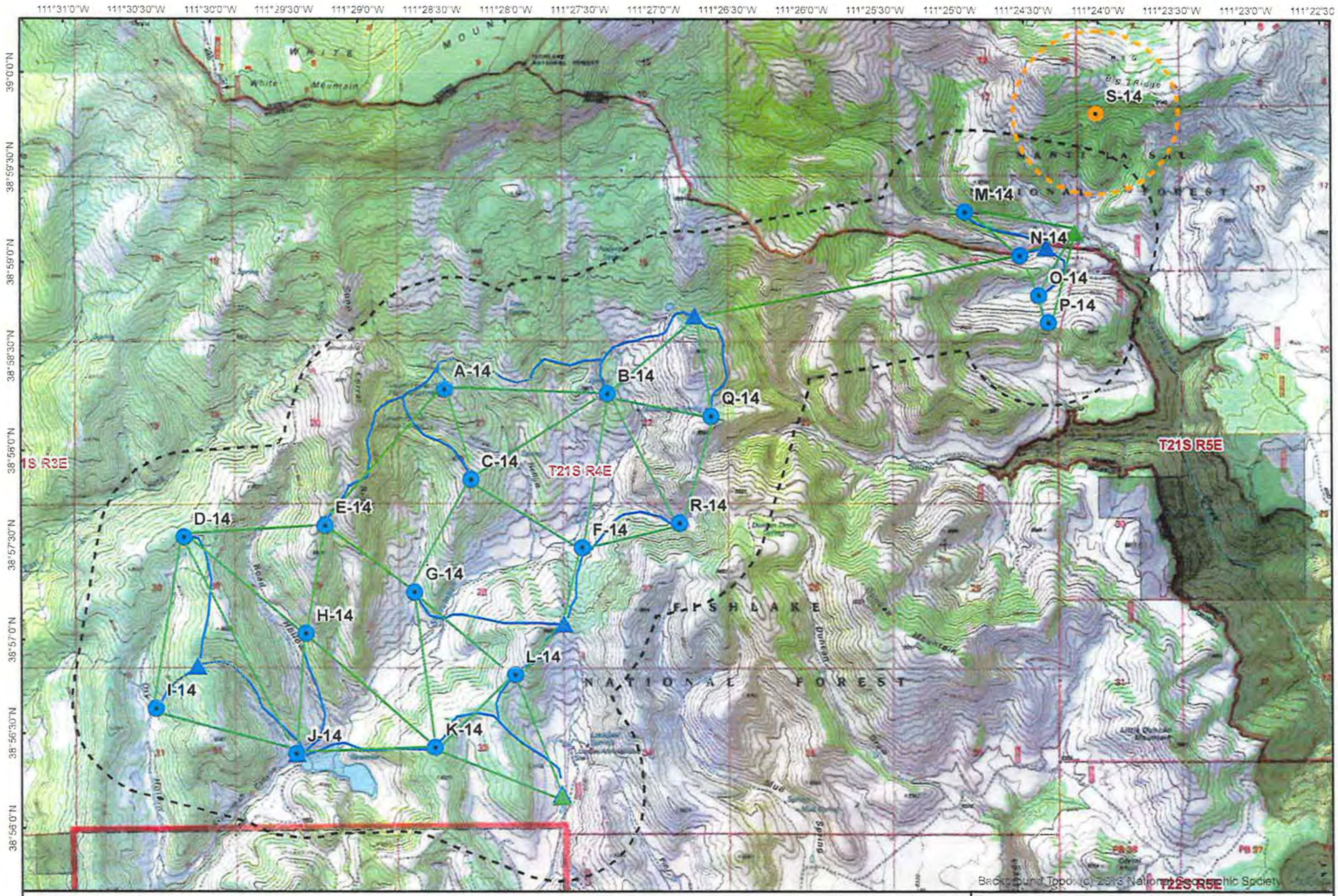
If you have any questions regarding the results of the survey or this report, please contact Mike Egan at 801-364-1064 extension 203.

Sincerely,
Tetra Tech, Inc.

Michael M. Egan

Michael Egan
Sr. Project Manager

Attachments: **Figure 1 (revised)**



Legend

- Additional Drill Hole
- Proposed Drill Location
- Helicop' ' Z & Staging Area
- Water Pump
- Flight Route
- 2" to 4" HDPE Waterline
- Half-mile Buffer Around Project
- Additional Buffer

0 0.25 0.5 1 Miles

N

TETRA TECH, I

Title: **Figure 1 (REVISED) 2014 Exploratory Drilling Project Biological Surveys**	
Client: Canyon Fuel Company, LLC SUFCO Mine	By: WR
Location: Sevier County, Utah	D. 7/22/2014

TETRA TECH

136 East South Temple, Suite 910
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Technical Memorandum

To:	Mark Bunnell	**From:**	Tetra Tech: Mike Egan, Project Manager Justin DeCaro, Wildlife Biologist James Hart, Wildlife Biologist
Company:	Bowie Resource Partners LLC SUFCO Mine 597 South SR 24 Salina, UT 84654		
CC:	Kreig Rasmussen, USDA Forest Service	**Date:**	06/10/2014
Re:	Biological Surveys for the Proposed 2014 Exploration Drill Holes	**Project:**	114-520226

Mr. Bunnell:

On behalf of Bowie Resource Partners LLC (dba Canyon Fuel Company, LLC), Tetra Tech Inc. (Tetra Tech) conducted biological surveys in support of the 2014 SUFCO Mine proposed drilling exploration project located south of White Mountain in Sevier County. The project would occur within Skumpah Canyon on land administered by the U.S. Department of Agriculture, Forest Service (USFS), Fishlake National Forest (FLNF) and Manti-La Sal National Forest (MLNF) in Sections 13, 14, 15, 20, 21, 22, 27, 28, 29, 30, 31, 32 and 33, Township 21 South, Range 4 East. The project features consist of eighteen drill holes; temporary water tanks and pumps; temporary waterlines; helicopter flight paths; and two helicopter landing zone/staging areas (**Figure 1**). Two biological surveys were conducted, the first from May 19 to May 22, 2014 and the second from June 2 through June 5, 2014.

Prior to conducting surveys, Tetra Tech biologist Justin DeCaro consulted Mr. Kreig Rasmussen of the USFS for specific survey requirements for this project. In particular, Mr. Rasmussen requested that Tetra Tech biologists' thoroughly survey suitable greater sage-grouse (*Centrocercus urophasianus*) habitat near disturbance features. He stated that there is suitable habitat for the sage-grouse on the north end of the FLNF along the boundary with the Manti-La Sal National Forest, but that the USFS has not located any sage-grouse or identified signs that sage-grouse are using the area. He observed sage grouse this spring, approximately 1 mile east of Quitchupah Canyon towards Wildcat Knolls. The biological surveys conducted for this project include:

- Two broadcast vocalization surveys for northern goshawk (*Accipiter gentilis)*
- Raptor nest survey
- Visual encounter surveys for:
    1. Greater Sage Grouse
    2. Pygmy rabbit (*Brachylagus idahoensis*)
    3. Western boreal toad (*Bufo boreas*)

4. U.S. Fish and Wildlife Service (USFWS) federally listed plant, wildlife, and aquatic species for Sevier County
5. Other USFS Sensitive Species
6. USFS Management Indicator Species (MIS)
7. Utah Division of Natural Resources (UDWR) Species of Concern (SPC) that have potential to occur in Sevier County
8. Migratory Bird Species

SURVEY METHODS

Northern Goshawk Broadcast Vocalization Surveys

Northern goshawk broadcast vocalization surveys were conducted following the USFS protocol (Woodbridge and Hargis 2006). At each calling station, a northern goshawk alarm call was broadcast for 10 seconds, followed by 30 seconds of attentive listening and watching. Biologists would then repeat this sequence two more times, rotating the broadcaster 120 degrees between each call. Calls were broadcast on calm days no earlier than one-half hour before sunrise and no later than one-half hour after sunset.

The survey area was a 0.5-mile buffer around all project features associated with the exploration area. Survey calling points were located within suitable habitat along flight lines and at each project feature, at least 200 meters apart. The area was surveyed two times, with visits 11 days apart. Photos were taken at each drill site to document habitat conditions.

Raptor Nest Surveys

Raptor nest surveys were conducted following guidance from the 2010 State of Utah Department of Natural Resources, Division of Oil, Gas, and Mining *Raptor Survey Guidelines* (DOGM 2010). All suitable nesting habitat identified in the exploration area and the accompanying 0.5-mile buffer were surveyed (including stands of conifer, aspen (*Populus tremuloides*) or other trees; and cliff areas). Locations of any raptor nests encountered during the surveys were recorded using a Global Positioning System (GPS) unit. Photos were acquired if possible. Biologists also recorded any individual raptors that were observed while walking and driving throughout the project area. Spotting scopes and binoculars were used to identify raptor species, verify the presence of nests and determine nest condition and activity.

Visual Encounter Surveys

Surveys were conducted throughout the exploration area and the accompanying 0.5-mile buffer for the following:

- Suitable sagebrush habitat was surveyed for visual presence and signs of greater sage-grouse including scat and feathers.
- Suitable sagebrush habitat was also surveyed for visual presence and signs of pygmy rabbits including scat and burrows.
- All streams and wetlands occurring in the survey area were surveyed for western boreal toads by slowly walking around the perimeter of the feature.
- Visual encounter surveys for USFWS federally listed species, other USFS Sensitive, USFS MIS's, UDWR SPC, all migratory bird species, and any other incidental species were also conducted in conjunction with all of the above surveys. The locations of any of these species encountered during the survey were recorded.

RESULTS: HABITAT ASSESSMENT

Drill Sites

- Drill Site A-14: Located on top of a ridgeline. Vegetation is dominated by grass, snowberry (*Symphoricarpos albus*), aspen (*Populus tremuloides*), sagebrush (*Artemisia tridentata*), and Gambel oak (*Quercus gambelii*).

- Drill Site B-14: Located on top of small, open ridge. Vegetation consists of sparse sagebrush surrounded by serviceberry (*Amelanchier alnifolia),* Gambel oak, and limber pine (*Pinus flexilis).*

- Drill Site C-14: Located on top of a ridge. Vegetation consists of sparse sagebrush, mountain mahogany *(Cercocarpus montanus*), antelope bitterbrush (*Purshia tridentata)*, and limber pine.

- Drill Site D-14: Located on top of a ridge. Vegetation consists of patchy Gambel oak, antelope bitterbrush and sparse Rocky Mountain juniper (*Juniperus scopulorum).*

- Drill Site E-14: Located on top of ridge with a northern aspect. Vegetation consists of sagebrush, scattered serviceberry, and scattered limber pine.

- Drill Site F-14: Located on bottom of slope near valley floor. Vegetation consists of sparse sagebrush intermixed with grass species. Drill site surrounded by small, scattered stands of aspen. Small, flowing creek approximately 100 meters west/northwest of drill site location.

- Drill Site G-14: Located in the bottom of drainage. Vegetation consists of sagebrush, grass species, and scattered Gambel oak.

- Drill Site H-14: Located on bottom of slope near the valley floor. Vegetation consists of sparse sagebrush intermixed with grass species, and mountain mahogany.

- Drill Site I-14: Located on bottom of slope near the valley floor. Vegetation consists sparse sagebrush intermixed with grass species.

- Drill Site J-14: Located on bottom of slope near the valley floor. Vegetation consists of sparse sagebrush intermixed with grass species, and sparse Rocky Mountain juniper.

- Drill Site K-14: Located on a south-west aspect, near the top of a ridge. Vegetation consists of sparse sagebrush, Gambel oak, antelope bitterbrush, and serviceberry. A small, isolated stand of aspen located approximately 100 meters to the west of drill site location.

- Drill Site L-14: Located on south-west aspect, on top of ridge. Vegetation consists of sparse sagebrush, serviceberry, and mountain mahogany.

- Drill Site M-14: Located in bottom of small, narrow drainage approximately 50 meters from flowing creek. Vegetation consists of sagebrush intermixed with grass species in the bottom of drainage. South facing slope composed of juniper species, mountain mahogany and large, scattered boulders. North facing slope composed of aspen/mixed-conifer species.

- Drill Site N-14: Located near bottom of south facing slope. Vegetation consists of sagebrush, scattered Gambel oak, and serviceberry. There are a few small, isolated stands of aspen scattered in the drainage. Drainage has a small, intermittent stream channel with scattered willows (*Salix* spp.) present.

- Drill Site O-14: Located in bottom of drainage. Vegetation consists of sagebrush intermixed with grass species. Small stock pond with water located approximately 200 meters west of drill site location.

- Drill Site P-14: Located on a small saddle on top of a ridge. Vegetation consists of sparse sagebrush intermixed with sparse grass species.

- Drill Site Q-14: Located in small, open meadow on north-east aspect. Vegetation consists of sagebrush, snowberry, scattered aspen, scattered limber pine, and scattered Douglas-fir (*Pseudotsuga menziesii*).

- Drill Site R-14: Located in bottom of narrow drainage. Vegetation consists of sagebrush throughout drainage bottom. South facing slope composed of Gambel oak, and scattered pinyon-juniper. North facing slope composed of aspen/mixed-conifer species.

Flight Paths, Helicopter Staging Area, Water Tanks, and Waterlines

Flight paths between individual drill sites and the staging areas are located in Section 13, 14, 15, 20, 21, 22, 27, 28, 29, 30, 31, 32, 33, and T21S R4E on the FLNF and MLNF. Habitat within the flight paths consists of mixed conifer, aspen/mixed-conifer, aspen, Gambel oak woodland, pinyon-juniper woodland, montane shrubland, and sagebrush shrubland.

The helicopter staging areas are located in T21S R4E Section 13 and 33. Habitat around the staging area consists of sagebrush shrubland. USFS Road 007 is within the direct vicinity of the both staging areas.

RESULTS: SURVEY RESULTS

The weather on May 19th through May 22nd, 2014 was between 55-70 degrees Fahrenheit, with clear skies becoming partly cloudy in the afternoon, and variable winds of zero to five miles per hour (mph). Weather during the second visit on June 2nd through June 5th, 2014 was approximately between 60-75 degrees Fahrenheit, with clear skies, and variable winds of zero to fifteen mph.

Northern Goshawk Survey Results

The ability to detect northern goshawk or other raptor nests was excellent because a majority of the aspen trees were not leafed out during the first visit. No northern goshawks or northern goshawk nests were detected within the survey area. The majority of the habitat in the survey area is not suitable for goshawk nesting due to the lack of expansive, mature stands of timber. The most suitable northern goshawk habitat within the 2014 exploration area is the mixed conifer, aspen/mixed conifer stands in the area north and northwest of drill holes A-14, B-14, E-14, Q-14 and R-14.

Raptor Nest Survey Results

No new raptor nests were identified during the survey. A Cooper's hawk (*Accipiter cooperii*) and a pair of Golden Eagles were the only raptors observed within the survey area. The Golden Eagle pair was observed approximately 100 meters north of G-14. They appeared to be foraging. They were not exhibiting territorial behavior, and no nest was detected. The Cooper's hawk was observed approximately 200 meters west of R-14. It was not exhibiting territorial behavior, and no nest was detected.

Visual Encounter Survey Results

No greater sage-grouse, pygmy rabbit, or boreal toad or their sign were observed within the project area. Skutumpah creek was surveyed for boreal toad, but none were detected. Surveys for boreal toad were also conducted at Skutumpah spring, Lizonbee springs, and around Skutumpah reservoir. No detections were made at these locations.

No USFWS threatened, endangered, candidate, or proposed species; other USFS Sensitive; other USFS MIS's; or UDWR SPC species were documented within the project area. **Table 1** lists migratory bird species observed within the project area during the 2014 surveys. Other wildlife species observed during the surveys include mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*).

If you have any questions regarding this memo, please contact Mike Egan at 801-364-1064 extension 203.

Sincerely,
Tetra Tech, Inc.

Michael M. Egan

Michael Egan
Sr. Project Manager

Attachments: **Figure 1**
Table 1

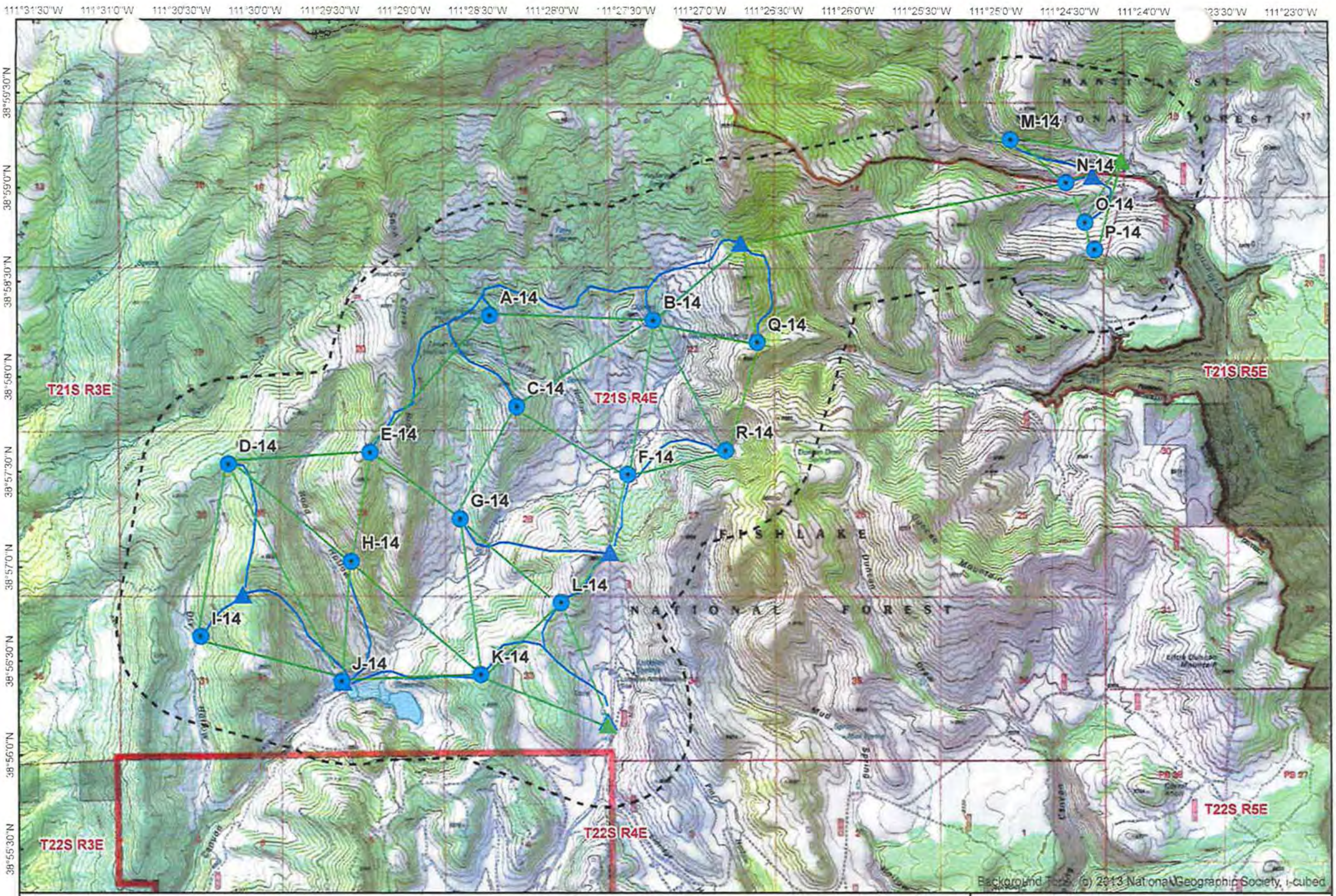
REFERENCES

Division of Oil, Gas and Mining (DOGM). 2010. *Raptor Survey Guidelines.* March, 2010. 23 pp.

Woodbridge, B. and C.D. Hargis. 2006. *Northern Goshawk Inventory and Monitoring Technical Guide.* Gen. Tech. Rep. WO-71. Washington, DC: U.S. Department of Agriculture, Forest Service. 80 pp.

Table 1: Migratory Bird Species Observed Within the SUFCO 2014 Exploration Drilling Project Area, May-June 2014

American Kestrel (*Falco sparverius*)
American Robin *(Turdus migratorius)*
Black-billed Magpie (*Pica hudsonia*)
Black-capped Chickadee (*Poecile atricapillus*)
Black-headed Grosbeak (*Pheucticus melanocephalus*)
Brewer's Sparrow (*Spizella breweri)*
Cassin's Finch (*Carpodacus cassinii)*
Cassin's Vireo (*Vireo cassinii*)
Chipping Sparrow (*Spizella passerine)*
Clark's Nutcracker (*Nucifraga columbiana)*
Common Raven (*Corvus corax)*
Cooper's Hawk (*Accipiter cooperii)*
Dark-eyed Junco (*Junco hyemalis*)
Dusky Flycatcher **(***Empidonax oberholseri)*
Gray Flycatcher (*Empidonax wrightii)*
Green-tailed Towhee (*Pipilo chlorurus)*
Hairy Woodpecker (*Picoides villosus)*
House Wren (*Troglodytes aedon*)
MacGillivray's Warbler (*Geothlypis tolmiei*)
Mountain Bluebird (*Sialia currucoides)*
Mountain Chickadee (*Poecile gambeli*)
Northern Flicker (*Colaptes auratus)*
Orange-crowned Warbler (*Oreothlypis celata*)
Plumbeous Vireo (*Vireo plumbeus*)
Red-breasted Nuthatch (*Sitta canadensis)*
Red-naped Sapsucker (*Sphyrapicus nuchalis*)
Red-tailed Hawk (*Buteo jamaicensis*)
Ruby-crowned Kinglet (*Regulus calendula)*
Spotted Towhee (*Pipilo maculatus)*
Stellar's Jay (*Cyanocitta stelleri)*
Turkey Vulture (*Cathartes aura)*
Vesper Sparrow (*Pooecetes gramineus)*
Virginia's Warbler (*Oreothlypis virginiae*)
Warbling Vireo (*Vireo glivus)*
Western Wood-pewee (*Contopus sordidulus)*
White-crowned Sparrow (*Zonotrichia leucophrys)*
Yellow-rumped Warbler (*Dendroica coronata)*
Yellow Warbler (*Setophaga petechia*)



Legend

- Proposed Drill Location
- Helicopter LZ & Staging Area
- Water Tank/Pump
- Flight Route
- 2" to 4" HDPE Waterline
- Half-mile Buffer Around Project

TETRA TECH, INC.

0 0.25 0.5 1 Miles

N

Title: Figure 1 2014 Exploratory Drilling Project Biological Surveys	
Client: Canyon Fuel Company, LLC SUFCO Mine	By: WR
Location: Sevier County, Utah	Date: 6/10/2014

TETRA TECH

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Salt Lake City Utah 84111
Tel 801-364-1064 Fax 801-364-2021
www.tetratech.com

Technical Memorandum

To:	Ms. Vicky Miller Bowie Resource Partners, LLC	**From:**	Tetra Tech: Mike Egan, Project Manager Justin DeCaro, Wildlife Biologist
Company:	Sufco Mine 597 South SR 24 Salina, UT 84654	**Date:**	07/11/2014
Re:	2014 Raptor Surveys	**Project:**	114-520224

On behalf of Bowie Resource Partners, LLC (Bowie), Tetra Tech, Inc. (Tetra Tech) conducted raptor nest surveys (including northern goshawk calling surveys) on May 5 and 6, 2014 and June 17 and 18, 2014 at the Sufco Mine in support of annual raptor monitoring requirements. The survey encompassed two areas: (1) the 2014 Raptor Survey Area (boundary provided by Bowie) and (2) the Waste Rock Disposal Area plus one-mile buffer. **Figure 1** presents a topographical map showing the location of the survey areas.

The 2014 Raptor Survey Area is located on private and state land as well as public land administered by the Bureau of Land Management (BLM), U.S. Department of Agriculture (USDA) Forest Service Fishlake National Forest (FLNF), and Manti-La Sal National Forest (MLNF). The Waste Rock Disposal Area is located on private property surrounded by the FLNF. As shown on **Figure 1**, the Waste Rock Disposal Area is located in Section 18 in Township (T) 22 South(S) Range (R) 4 East (E). The 2014 Raptor Survey Area is located in all or portions of:

- Sections 13, 14, 15, 22, 23, 24, 25, 26, 27, 34, 35 and 36 in T21S R4E
- Sections 17, 18, 19, 20, 29, 30, 31, and 32 in T21S R5E
- Sections 1, 2, 3, 10, 11, 12, 13, 14, 15, and 24 in T22S R4E
- Sections 5, 6, 7, 8, 17, 18, 19, 20, 25, 26, 35, and 36 in T22S R5E
- Sections 30 and 31 in T22S R6E
- Sections 1, 2, 3, 11, and 12 in T23S R5E

SURVEY METHODS

Raptor Surveys

Raptor surveys were conducted following guidance from the 2010 State of Utah Department of Natural Resources, Division of Oil, Gas and Mining (DOGM) *Raptor Survey Guidelines* (DOGM 2010). All suitable nesting habitat identified in 2014 Raptor Survey Area and the Waste Rock Disposal Area were surveyed. There were 38 previously known raptor nests within the survey areas (**Figure 1**). All previously known nests in the survey areas were visited in May to determine nesting activity. Nests that were determined active in May were revisited in June 2014 to determine productivity.

The locations of any new raptor nests encountered during the surveys were also recorded. Biologists also recorded any individual raptors that were observed while walking and driving throughout the survey areas. Spotting scopes and binoculars were used to identify raptor species, verify the presence of nests (historic and new), and determine nest condition and activity.

Northern Goshawk Broadcast Vocalization and Intensive Search Surveys

Northern goshawk (*Accipiter gentilis*) broadcast vocalization surveys were conducted following the Forest Service protocol (Woodbridge and Hargis 2006) as specified in the DOGM guidelines (DOGM 2010). Tetra Tech consulted with USFS biologist, Mr. Jeff Jewkes, prior to the field season. In the past, the first goshawk survey was being conducted during the month of May at the Sufco Mine. Mr. Jewkes indicated that a survey in May was not necessary and does not fall in line with Woodbridge and Hargis (2006) protocol in terms of the timing of acoustical broadcast surveys. Mr. Jewkes also indicated that one survey was adequate because the habitat in the survey area is not optimal for goshawk nesting due to the lack of expansive, mature stands of mixed-conifer and aspen/mixed-conifer. Therefore, only one northern goshawk survey was conducted.

Survey calling stations were located throughout potential goshawk nesting habitat (i.e., wooded/forested areas) in the survey areas, and were spaced at least 200 meters apart. At each calling station, a northern goshawk alarm call was broadcast for 10 seconds, followed by 30 seconds of attentive listening and watching. Biologists would then repeat this sequence two more times, with 120 degrees of rotation between each call. Calls were broadcast on calm days no earlier than one-half hour before sunrise and no later than one-half hour after sunset.

An intensive search during travel between each call station was also conducted. This included listening for vocalizations and looking in mature trees for potential nesting sites. Biologists also inspected the ground for white wash, prey remains and feathers. The locations of any individuals goshawks encountered during the survey were also recorded.

Incidental Observations

During travel throughout the Raptor Survey Area and Waste Rock Disposal Area, any occurrences of special status species of flora and fauna were recorded. This included migratory bird species and FLNF and MLNF management indicator species (i.e. elk (*Cervus canadensis*) calving, mule deer (*Odocoileus hemionus*) fawning, and greater sage-grouse (*Centrocercus urophasianus*)). In addition, observations of other incidental wildlife species within the survey areas were also documented.

RESULTS: HABITAT ASSESSMENT

Habitat within the Raptor Survey Area and Waste Rock Disposal Area consists primarily of sagebrush (*Artemisia tridentata*) shrublands, mountain shrub, and small stands of conifer and aspen (*Populus tremuloides*). The Waste Rock Disposal Area contains small patches of mixed conifer and aspen, intermixed with the sagebrush and mountain brush species.

RESULTS: SURVEY RESULTS

The weather on May 5 and 6, 2014 was approximately 60 degrees Fahrenheit, with partly cloudy/cloudy skies, and variable winds of zero to ten miles per hour. Weather during the second visit on June 17 and 18, 2014 was approximately 60 degrees Fahrenheit, with overcast skies and winds of zero to fifteen miles per hour.

Raptor Survey Results

Of the 38 previously known nests that were surveyed, three were determined active. In addition, three new active nests were recorded. The new nests were added to Tetra Tech's nest database, and their locations are listed in **Table 1**. All nests are shown on **Figure 1**.

Table 1. New Raptor Nests Recorded at Sufco Mine in 2014.

Nest Number	Species	Location	UTM Coordinates (NAD 83)
TT10_RTHA	Red-tailed Hawk (*Buteo jamaicensis*)	Accord Lakes, E. side of Airport Rd. (private property – coordinates estimated)	459774, 4308678
TT11_GOEA	Golden Eagle (*Aquila chrysaetos*)	E. side of Convulsion Rd., approx. one mile from Waste Rock Disposal Area	466117, 4314116
TT12_GOEA	Golden Eagle (*Aquila chrysaetos*)	N. Fork of Quitchupah	455044, 4304993

There were a total of six active raptor nests documented in 2014 in the survey area. Field photos of the active nests are attached. These included four red-tailed hawk (*Buteo jamaicensis*) nests located in live trees or snags, and two golden eagle (*Aquila chrysaetos*) nests located on cliffs. A summary of activity at the active nests is presented in **Table 2**, and details are provided in the text below.

Table 2. Raptor Nest Activity at Sufco Mine in 2014.

Nest Number	Species	First Visit (May 5 and 6, 2014)	Second Visit (June 17 and 18, 2014)
TT4_RTHA	Red-tailed Hawk	2 adults	No birds present
TT7_RTHA	Red-tailed Hawk	2 adults	No birds present
TT9_RTHA	Red-tailed Hawk	1 adult	4 nestlings
TT10_RTHA	Red-tailed Hawk	1 incubating adult	No birds present
TT11_GOEA	Golden Eagle	2 nestlings	2 fledglings
TT12_GOEA	Golden Eagle	1 adult feeding 2 nestlings	No birds present

<u>Red-tailed Hawk Nests</u>

During the first survey in early May, the four red-tailed hawk nests had only adult birds present, either singly or in pairs. During the second survey to determine nest productivity, three of the red-tailed hawk nests had no birds present, either adult or young. Red-tailed hawks in Utah typically incubate eggs for 30-35 days, and fledge approximately 45 days after hatching (Romin and Muck 2002); therefore, nestlings should have been present during the second visit. For this reason, these three nests are likely nest failures. The fourth red-tailed hawk nest (TT9_RTHA) had nestlings present during the second survey, but productivity was not determined since the young had not yet fledged.

Golden Eagle Nests

Nestlings were present in the two active golden eagle nests during the first survey in early May. During the second survey in mid-June, one of the nests (TT11_GOEA) had two fledglings present and is considered a successful nest. The other nest had no adult or young present. This nest was also checked in early June during other surveys in the area, and was also empty at that time. Once hatched, golden eagles fledge within 66-75 days and are typically associated with a nest for an additional 14-20 days post-fledging (Romin and Muck 2002). Therefore, young should have been present at the nest during the second survey. For this reason, nest TT12_GOEA is likely a nest failure.

Other Raptor Observations

One other raptor species was observed in the survey areas. During the second survey, a northern harrier *(Circus cyaneus)* fledgling was observed near Mud Spring Hollow.

Northern Goshawk Survey Results

No northern goshawks or northern goshawk nests were detected within the survey areas. The habitat in the survey areas is not optimal for goshawk nesting due to the lack of expansive, mature stands of mixed-conifer and aspen/mixed-conifer forest.

Incidental Observations

No special status species of flora and fauna, including FLNF and MLNF management indicator species (i.e., elk calving, mule deer fawning and greater sage-grouse breeding/nesting) were observed within the survey areas. **Table 3** (attached) lists migratory bird species observed within the survey areas during the May and June 2014 surveys.

If you have any questions regarding this memo, please contact Mike Egan at 801-364-1064 extension 203.

Sincerely,
Tetra Tech, Inc.

Michael M. Egan

Michael Egan
Sr. Project Manager

Attachments: **Figure 1**
Table 3
Field Photos

REFERENCES

Division of Oil, Gas and Mining (DOGM). 2010. *Raptor Survey Guidelines.* March, 2010. 23 pp.

Romin, L.A. and J.A. Muck. 2002. Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances. U.S. Fish and Wildlife Service, unpublished report.

Woodbridge, B. and C.D. Hargis. 2006. *Northern Goshawk Inventory and Monitoring Technical Guide.* Gen. Tech. Rep. WO-71. Washington, DC: U.S. Department of Agriculture, Forest Service. 80 pp.

Table 3: Migratory Bird Species Observed Within the Sufco 2014 Raptor Survey Area and Waste Rock Disposal Area, May and June 2014

American Robin *(Turdus migratorius)*
Black-billed Magpie (*Pica hudsonia*)
Black-capped Chickadee (*Poecile atricapillus*)
Brewer's Sparrow (*Spizella breweri*)
Cassin's Finch (*Carpodacus cassinii*)
Cassin's Vireo (*Vireo cassinii)*
Chipping Sparrow (*Spizella passerine*)
Clark's Nutcracker (*Nucifraga columbiana*)
Common Raven (*Corvus corax*)
Dark-eyed Junco (*Junco hyemalis*)
Mountain Bluebird (*Sialia currucoides*)
Northern Flicker (*Colaptes auratus)*
Plumbeous Vireo (*Vireo plumbeus)*
Spotted Towhee *(Pipilo maculatus)*
Stellar's Jay (*Cyanocitta stelleri*)
Townsend's Solitaire (*Myadestes townsendi*)
Tree Swallow *(Tachycineta bicolor)*
Vesper Sparrow *(Pooecetes gramineus)*
Violet-green Swallow (*Tachycineta thalassina*)
Western Bluebird (*Sialia mexicana*)
Western Tanager *(Piranga ludoviciana)*
Yellow-rumped Warbler (*Dendroica coronata*)

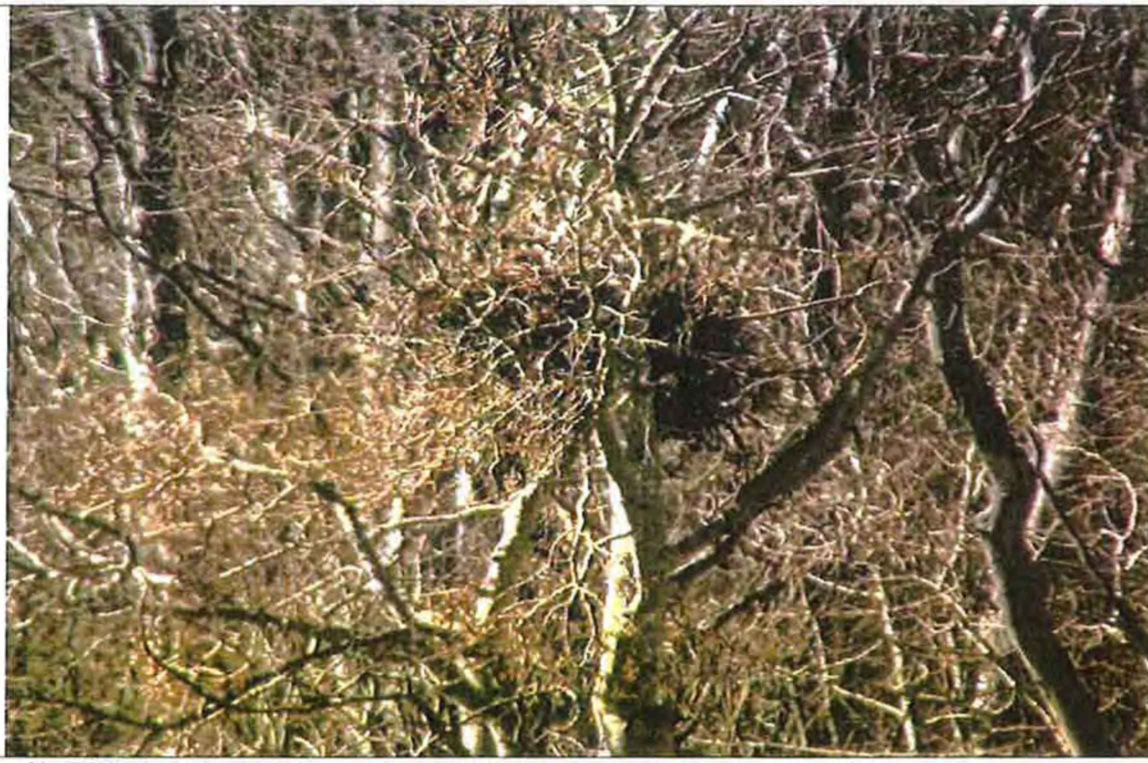
FIELD PHOTOS

TT11_GOEA: Golden Eagle Active Nest – First Survey, 5/5/2014.

TT11_GOEA: Golden Eagle Active Nest - Second Survey, 6/17/2014.

TT12_GOEA: Golden Eagle Active Nest – First Survey, 5/6/2014.

TT10_RTHA: Red-tailed Hawk Active Nest – First Survey, 5/5/2014



TT9_RTHA: Red-tailed Hawk Active Nest – First Survey, 5/6/2014

TT9_RTHA: Red-tailed Hawk Active Nest – Second Survey, 6/18/2014

CHAPTER 4

LAND USE AND AIR QUALITY

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(Appendices appear in Volume 6)

CHAPTER 4

LAND USE AND AIR QUALITY

4.10 Land Use

This section of the permit application includes descriptions of the premining and proposed postmining land use(s).

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

4.1.1 Environmental Description

A statement of the conditions and capabilities of the land to be affected by coal mining and reclamation operations follows in this section.

4.1.1.1 Premining Land Use

The surface lands within the lease and permit areas (except for 640 acres privately owned) are owned by the U.S. Government and are either parts of the Fishlake National Forest, the Manti-La Sal National Forest or lands administered by the Bureau of Land Management. These lands have been inventoried by the respective regulatory agencies who are responsible for the administration and use of these government lands. Federal comprehensive land use plans have been prepared by the U.S. Forest Service Offices.

Land Use Map. Plates 4-1A & 4-1B presents these Federal comprehensive land use plans information in the lease and permit areas.

Land Capability. The SUFCO Mine area's recreational use (excluding hunting) is approximately 427 days annually. Most of this use is dispersed among horseback riding, snowmobiling, hiking, camping, four wheeling and fuel wood gathering (Billy Dye, Ferron Ranger District; Bob Tuttle, Fishlake National Forest).

The major plant communities in the SUFCO Mine area are identified in Section 3.2.1.1.

The pinyon/juniper woodland occurs on steep unstable slopes and is considered unsuitable for grazing although it is grazed within the allotment. The vegetation condition within the pinyon/juniper woodland type was considered good. Forage production (mainly Indian rice-grass and bluebunch wheatgrass) is low. Arnold et. al. (1964), Jameson and Dodd (1964), and Jameson (1971) found that as tree canopy increased, understory vegetation decreased. Phillips (1965) found that mature stands with a 74 per unit crown canopy produced 96 pounds of forage per acre while stands with 1-2 percent cover produced from 418-577 pounds per acre. Lewis et. al. (1965-1967) found production values between 40 and 460 pounds per acre in stands sampled. Areas where trees had been removed produced as much as 900 pounds per acre. Canopy cover of pinyon and juniper in the SUFCO Mine Quitchupah lease area fairly dense and forage production in the type would generally be less than 100 lbs./acre in an average year. Assuming 50 percent utilization and 25 lbs./animal/day, it would take 15 acres to carry an animal for a month (WESTECH, 1978).

A large part of the flatter upland area is dominated by sagebrush/ grassland. The U.S. Forest Service (unpublished, 1971) has mapped this area as suitable rangeland with vegetation condition. The sagebrush/grassland type within the SUFCO Mine Quitchupah lease area is the most desirable type for grazing, producing the most available forage per acre for livestock. It generally has lower vegetation condition than other types indicating it receives heavier grazing pressure. Three transects established in 1971 by the U.S. Forest Service on the SUFCO Mine Quitchupah lease area averaged 1100 lbs/acre (dry weight). Of this, about 940 lbs/acre was perennial grasses and sedges. The transects established, however, are in areas where shrub coverage is low and forage production would probably be lower for most of the sagebrush/grassland type where shrub coverage is higher. For this type, it would take 2-3 acres to carry an animal for a month. The U.S.

Forest Service estimates a carrying capacity of 0.5 animal units per month (AUM) per acre (B. Bass personal correspondence, 1979).

The aspen type is an important producer of forage for big game and domestic stock. A high percentage of the production is forbs which makes this type more desirable to big game and sheep. Mature aspen with a herbaceous understory in good to excellent condition will produce from 1,000 to 1,800 lbs/acre air dry forage (Lewis, 1971). The U.S. Forest Service estimates that in this area, aspen type produces 1,000 to 1,500 lbs/acre with 0.6 to 0.65 AUM/acre (M. Stubbs personal correspondence, 1979). Most of the aspen stands in the SUFCO Mine Quitchupah lease area serial with vegetation condition (U.S. Forest Service, unpublished, 1971).

The ponderosa pine, mountain shrub and coniferous forest types are generally lower forage producers although the extent of these types on the study area makes them an important component of the grazing system. Portions of these types, especially along the steep canyon walls, have been rated unsuitable for grazing and receive little grazing pressure due to limited accessibility to livestock. Areas of these types on more gentle slopes receive heavier grazing as indicated by lower vegetation condition. These areas provide some forage for livestock and are valuable forage producers for big game. Julander (1955) estimated forage production for mountain brush and oak types. He found that the mountain brush type produced 723 lbs/acre (green weight) of which 11 lbs/acre were grasses. He found that grasses are preferred forage for cattle and are selected as their key forage species. Where grasses were unavailable, however, cattle used forb and shrub species resulting in competition with big game species.

Valley bottoms receive little grazing pressure except in the vicinity of water sources where pressure is locally heavy. Valley bottoms are generally narrow and represent limited available forage. Steep slopes receive limited grazing pressure from livestock because of the steep inclines and lack of water. Flatter mesa tops and rolling terrain receive heavier pressure because of easier movement by livestock and more available forage. Grazing pressure is heaviest around water sources in these more accessible areas.

Very little of the SUFCO Mine area is in vegetation communities capable of producing timber products. The pinyon/juniper woodland community generally occurs on steep, unstable slopes making it undesirable for accessibility.

The coniferous forest type also occurs on steep slopes and generally in small stands. Economics of harvesting these stands would result in a high cost/benefit ratio. Other than very limited consumption for posts and poles, this type receives no use in the area as a timber producer. Christmas tree cutting, however, is higher in this community type than others in the area.

The ponderosa pine type is the only vegetation community receiving substantial use for timber production. This type generally occurs on flatter sandy sites and is readily accessible. Large, mature (250 + years) trees have been harvested on a selective basis. Pine regeneration in cut over stands is sparse and mountain mahogany and manzanita appear to be increasing in the understory. Within the SUFCO Mine Quitchupah lease area approximately 528 thousand board feet (MBF) have been harvested between 1977 and 1978 with average volumes of 1.3 average net volume/acre (M. Stubbs personal correspondence, 1979). Quaking aspen stands receive limited local pressure for posts and poles.

The vegetation communities supported in the Pines Tract area and SITLA Muddy Tract area are discussed in Chapter 3 of this M&RP.

Land Use Description. The leased areas lie within the Manti-La Sal and Fishlake National Forests and are subject to the Land and Resource Management plans prepared by the agency. These plans identify the principle use of the lease areas as rangeland with small areas set aside for timber harvesting and as general big game range. Recreation in the lease areas includes camping, firewood gathering, hunting, some snowmobiling, and sight seeing from late spring to late fall. Yearly recreation use is light, but during deer and elk hunts, use is extremely heavy.

There are no developed or inventoried recreation campgrounds on the lease areas. The mining operation will not impact any of these uses and will preserve the uses into the postmining period.

The timber on the lease areas are open grown Ponderosa pine. All commercial stands occur on the benches. Trees are of low quality because of the poor tree growing site. Cutting is limited to older over-matured trees and occurs infrequently. No adverse timber impacts are anticipated.

The aesthetic value of the area has been categorized by the U.S. Forest Service as follows: "The mesa rim and deep canyons can be seen as background from Emery (Dog Valley). They are classified as distinctive with variety. Activity from the proposal will not be visually evident from the valley. The lease area is seen as middle ground from a few remote spots on the Duncan Mountain Road. This scene area is presently classified in Sensitivity Level 2 (Average Sensitivity). The visual objective as recommended by the Land Use Plan is 2 (Modification). This permits activities to visually dominate the characteristic landscape. Very few people visit the area and those that do, come for something other than scenic attractions."

With the inclusion of the Pines Tract into the SUFCO lease and permit areas "changes in the existing landscape could include escarpment failures. This is not expected to change the visual character of the region."

A portion of the surface area is grazed by cattle under the Quitchupah Grazing Association allotment (Fishlake National Forest). The allotment covers approximately 43,156 acres, it presently supports 813 head of cattle from June 11 through September 30, for a total of 2,981 cow months (Bob Tuttle, Fishlake National Forest).

The Emery allotment (Manti-La Sal Forest) supports 1,300 head of cattle. This allotment is under an intensive rest-rotation management system, placing the cattle in the mine area for approximately one month a year. Several ranches in Emery County are dependent on the allotment. Structural range improvements include one watering trough (spring fed) and two cattle guards on the access route into the lease.

The number of hunters in the Salina Planning Unit increased 122 percent from 1969 to 1972 (U.S. Forest Service, 1976). In Deer Unit #43/45 (Salina) 9,383 hunters were recorded afield during the 1990 hunting season. The Fishlake Elk Herd Unit #14 hosted 4,027 hunters during the 1990 season. Additional hunter use information reported by the Utah Division of Wildlife Resources can be found in the Utah Big Game Annual Report for 1991 (Appendix 4-1).

Pines Tract Area

The existing land uses in the Pines Tract area include: timber production, livestock grazing, wildlife habitat, recreation, transportation corridors and underground coal mining (SUFCO Mine). The existing land uses not previously discussed are the transportation corridors and underground coal mining (SUFCO Mine, Quitchupah Lease). The roads/transportation corridors are generally single-lane native surface forest development roads which are passable during the drier months of the year. The forest development roads connect with local roads that access major highways.

In the late 1970s two Roadless Area Review and Evaluation (RARE) II areas were inventoried. Neither area was designated as wilderness, nor were they classified as roadless or semi-primitive recreation management areas under the Forest Plan in 1986 (Pines Tract Project EIS, 1999).

The Pines grazing unit is part of the Emery C&H grazing allotment. The Pines unit supports 1,387 head of cattle during the early grazing season. Eight ponds for livestock and wildlife use have been developed in the Pines Tract area (see Chapter 3, Appendix 3-9, Figure 2 - Springs, Seeps and Riparian Areas). The Link Canyon troughs and the Joe Mill ponds are the most reliable sources of developed water within the tract area.

The limited amount of perennial water within the analysis area reduces the potential for many species of fish to be present. However, Muddy Creek and the lower portion of Box Canyon Creek support fish populations.

The Sevier County Zoning Resolution designates the area as GRF-1. The primary uses designated for GRF-1 areas include gravel pits, clay pits, rock quarries, oil and gas wells, mines, mineral reduction, processing structures and facilities. There are no oil or gas leases associated with the Pines Tract area.

Muddy Tract Area

The existing land uses in the SITLA Muddy Tract area include: timber production, livestock grazing, wildlife habitat, recreation, transportation corridors and underground coal mining (SUFCO Mine). The roads/transportation corridors are generally single-lane native surface forest development and maintenance roads which are passable during the drier months of the year. The roads are classified by the Forest as Level 2 roads and generally no restrictions are placed on these roads for public use. The Forest does recommend the use of high clearance vehicles for most of the roads in the SITLA Muddy Tract area and to avoid use when the road surfaces are wet. However, if the permittee is using the roads for other than periodic monitoring, special use permits must be obtained from the Forest. Many of the forest development roads connect with local roads that access major highways.

In the late 1970s two Roadless Area Review and Evaluation (RARE) II areas within the SITLA Muddy Tract region were inventoried. Neither area was designated as wilderness, nor were they classified as roadless or semi-primitive recreation management areas under the 1986 Forest Plan Revision (Pines Tract Project EIS, 1999). Recent re-inventories (July 2004) of Roadless Areas by the Manti LaSal National Forest as part of their Forest Plan Revision to be completed by the end of 2006 have included nearly all of the SITLA Muddy Tract as potentially "roadless". This designation excludes the existing Forest Development Roads 044, 2033, and 010 that lie within the eastern and northern portions of the SITLA Muddy Tract. Only a small segment of land west and north of the Main Fork of Box Canyon and western SITLA Muddy Tract boundary, east of Forest Road 044, and south of the southern boundary of sections 2, 3, and 4 of T 21 S., R 5 E., SLM is identified as not being included in the proposed roadless area. Currently, the Forest typically administers most of the areas identified as having "roadless" characteristics as though the areas were officially accepted as roadless. This action is being taken to preserve, where possible, unroaded characteristics of portions of the Forest.

The SITLA Muddy Tract area is part of the Emery C&H grazing allotment. The SITLA Muddy Tract unit supports 1,387 head of cattle during the early grazing season. Three ponds for livestock and wildlife use have been developed in the SITLA Muddy Tract area. The limited amount of perennial water within the analysis area reduces the potential for many species of fish to be present. However, Muddy Creek and the lower portion of Box Canyon Creek support fish populations.

There are no oil or gas leases associated with the SITLA Muddy Tract area.

Greens Hollow Tract

The area is not proximate to local communities and the access to the area is time consuming. Overall recreational use is light compared to other areas of the Forest, there are no small reservoirs or collector roads. Seasonal use begins in May and end following hunting season in October. Approximately 24 miles of forest road are used by OHV's 4WD's and conventional vehicles.

Noise levels vary in the tract area from, recreational vehicles, wood cutting and the mines exhaust fan. A noise study was conducted, sound levels ranged from 32. 8 dBA to 70.3 dBA. Higher sound level measurement taken at various monitoring locations could be a result of wind gusts. Appendix 3-15 contains a copy of Sound Study Report prepared by Tetra Tech.

The majority of the tract falls with the Emery Cattle and Horse Grazing Allotment (9,107 acres) on the Manti-La Sal National Forest. A small parcel on the north is on the Ferron Cattle and Horse Grazing Allotment (203 acres) also on the Manti-La Sal Forest. On the southern end of are tract on the Fishlake National Forest lies the Quitchupah Cattle and Horse Grazing Allotment (1,714 acres). The limiting factor for the allotments is stock water, spring-fed troughs provide the most reliable sources of stock water , with develped stock ponds and natural pond providing a less reliable source. Refer to Appendix 4-6 for figure showing range allotments.

Documented land uses for the Greens Hollow Tract include:
Livestock grazing, spring development and other water improvements (guzzler, etc), habitat improvement, prescribed burns, sage grouse brood rearing habitat, forest service road development, mining, recreation timber operations and private land access, dispersed camping and hunting, exploration drilling, and geophysical surveys. Underground room and pilling mining at the Ricci Mine was done in the area on the north slope of Muddy Creek.

The tract contains two Inventoried Roadless Areas (IRAs), the Muddy Creek-Nelson Mountain IRA is on the Manti and the White Mountain IRA on both the Fishlake and Manti. Five percent of the Muddy Creek IRA is in the tract and 10% of the White Mountain IRA is within the tract. The Wildcat Knoll IRA (0.6%)is with the the extended analysis area. Activities on the IRAs are subject to restrictions specified in the USFS 2001 Roadless Rule.

The Paiute Indian Tribe, Navajo Nation and Ute Indian Tribe were consulted, no sacred sites were identified in the course of the tribal consultation (FESEIS).

Cultural and Historic Resources Information. Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2. An intensive cultural resource evaluation of five coal exploration well locations has been conducted on the Quitchupah Lease by Dr. Richard Hauck of AERC (see Appendix 4-2). As part of this evaluation he also made a record search at the State Historic Preservation office and the National Register of Historic Places. No sites were found that would be effected by the drilling activity. A ten percent cultural resource potential survey was completed by Les Sikle, Forest Archeologist, Manti-La Sal National Forest. A copy of his report is included in Appendix 4-2 along with the Utah State Historical Society's concurrence letter.

An intensive cultural resource evaluation of a proposed breakout, substation and power line in the Link Canyon Locality conducted by Dr. Richard Hauck of AERC is included in Appendix 4-2. No cultural or paleoentological resources were observed within the proposed Link Canyon development area during the archaeological survey.

A cultural resource evaluation of the Link Canyon Mine portals area in Link Canyon was conducted by John Senulis of Senco-Phoenix. A copy of his report is included in Appendix 4-2. The conclusion of his evaluation of the portal site was that no cultural or paleoentological resources are present. Many of his conclusions were based on work previously performed in the immediate portal area and surrounding areas by Dames and Moore, AERC, JBR, and the BLM.

There are no cemeteries, public parks, historic places, or areas within the boundaries of any units of the National System of Trails or the Wild and Scenic Rivers System located in areas to be affected by the SUFCO Mine (See Appendix 4-6 for a description). The Applicant agrees, however, to notify the regulatory authority and the Utah State Historical Society of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria. Protection of eligible cultural resources will be in accordance with regulatory authority and Utah SHPO requirements. The Applicant will also instruct its employees that it is a violation of federal and state laws to collect individual artifacts or to otherwise disturb cultural resources.

150 Acre Incidental Boundary Change

Cultural and Historic Information. Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2. Dr. Richard Hauck of AERC conducted an intensive evaluation of the 150 acre IBC. Four new sites were discovered and recorded during the evaluation. All the sites are located on or near the east rim of Box Canyon. The sites include two significant rock shelters (42SV 2492 and 42SV 2495), a significant ceramic scatter (42SV 2493), and a non-significant kill-butchering locus (42SV 2494).

Site 42 SV 2492 - The site consists of a rock shelter. This site is considered to be a significant resource and excellent potential for National Register classification. The site is 15 meter wide with a sandstone arched roof and is susceptible to surface subsidence.

Site 42 SV 2493 - The site consists of ceramic scatter occupying an area of 20 to 30 meters on the bedrock top at the canyon rim. This site is considered to be a significant resource and has the potential for National Register classification. This site is not considered to be at-risk or susceptible to surface subsidence.

Site 42 SV 2494 - The site consists of a dispersed scatter of debris and lithic tool fragments and is situated on the bedrock on the east rim overlooking Box Canyon. This site is not considered to be a significant resources and lacks potential for National Register classification.

Site 42 SV 2495 - The site consists of a scatter of debris primarily on the north facing slope below the base of a shallow shelter under a sandstone ledge. The site is considered to be a significant resource and has limited potential for National Register classification. This site is not considered to be at-risk or susceptible to surface subsidence.

The Applicant agrees, however, to notify the regulatory authority and the Utah State Historical Society of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria. Protection of eligible cultural resources will be in accordance with regulatory authority and Utah SHPO requirements. The Applicant will also instruct its employees that it is a violation of federal and state laws to collect individual artifacts or to otherwise disturb cultural resources.

Pines Tract Area

Cultural and Historic Information. Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2. Dr. Richard Hauck of AERC made a record search at the State Historic Preservation office, National Register of Historic Places and conducted field investigations under state project numbers UT-96-AF-0443f and UT-97-AF-0598f. AERC coordinated the research and field investigations with SHPO.

Information concerning the potential of specific sites as to being either in the subsidence zone or out of the zone or being evaluated or unevaluated is contained in the Memorandum of Agreement between Federal and State agencies.

The monitoring, treatment plans and mitigation of the cultural resource sites will be in accordance with the Memorandum of Agreement (MOA) 00-MU-11041000-017, and any amendment to it, between the USFS - Manti-La Sal, USHPO, the Advisory Council on Historic Places, UDOGM, and the SUFCO Mine located in Appendix 4-5.

Sufco intends to undermine portions of the East Fork of Box Canyon beginning in the Fall of 2003 as they extract coal from the 3LPE and 4LPE longwall panels. This change in the mining plan will change the required monitoring schedule in accordance with the Memorandum of Agreement for site 42SV2430/ML-3446 - Elusive Peacock which will be undermined under the 3LPE longwall panel. In accordance with pages 11-12 of the MOA the required monitoring schedule of this site will change from Monitor Schedule A (Sites in areas that will be mined using full-support methods) to Monitor Schedule B (Sites in areas which will be mined under and subsided) requiring the implementation of additional monitoring of the site. Monitoring results will be provided in DOGM Annual Reports. (2003, 2004, 2005, 2006, and indefinitely until movement ceases)

Historic properties documented in the Pines Tract area include 42SV2424, a sawmill, and site 42SV2391 a complex of trash scatters. Both sites are considered ineligible for the NRHP.

The Applicant agrees, however, to notify the regulatory authority and the Utah State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria.

Muddy Creek Coal Tract Area

Cultural and Historic Information. Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2. Cirrus Ecological Solutions, LC conducted an intensive evaluation of the Muddy Tract Area. Thirty-four sites were documented during the evaluation. Refer to Confidential Appendix 4-2, "Muddy Creek Technical Report, Heritage Resources".

The three sites located in the SITLA Muddy Tract lease area are located on or near the east rim of Box Canyon. The sites include two significant lithic scatters (42SV2554 and 42SV2597), and a non-significant lithic scatter (42SV2594). None of these three sites will be undermined under the present mine plan.

The Applicant agrees, however, to notify the regulatory authority and the Utah State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria.

Results from USDA Manti-La Sal National Forest, Price Ranger District, Project #ML-02-1033, Utah State Project #U-02-MM-0311f, s, b, p

Site #	Site Type	Evaluation (Cirrus Ecological Solutions, LC)	Undermined/potential for impact by mining	Date Surveyed
42SV2584*	LS, RS,C	Significant	No/Not expected	1966(PI 1976)
42SV2596	LS, RS	Non-significant	No/Not expected	1966(PI 1976)
42SV2597	LS	Non-significant	No/Not expected	1966
42SV2554	LS	Significant	No/Not expected	1966
42SV2492	LS	Non-significant	No/Not expected	1966

LS - Lithic Scatter RS- Rock Shelter C-Ceramics

* Re-recorded on IMACS form, lumped ML#s 2281 and 2282 with this.

Site 42SV2584 and 42SV2596 lie within the boundary of the SITLA lease expansion (Section 32, T 20 S, R 5 E). According to a report prepared for the Manti-La Sal Forest by Cirrus Ecological Solutions, LC, site 42SV2584 is considered significant, while 42SV2596 is considered non-significant. In the current Sufco five year mine plan no mining is planned beneath either location and they do not lie within the angle-of-draw (Plate 5-10A), therefore no impact is anticipated to either site. Should the mine plan change where the eligible site could be impacted, the permittee will coordinate with DOGM and the USFS prior to mining.

Sites 42SV2584 and 42SV2596 were reevaluated by USFS archeologist in 2015. On 11/20/15, SHPO concurred with the USFS recommendation that site 42SV2584 be determined eligible and 42SV2596 be determined not eligible. A copy of the SHPO concurrence letter is located in Appendix 4-2 (Confidential) of the M&RP.

West Coal Lease Modification Areas

Cultural and Historic Information. Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2 in the Confidential folder of the M&RP. EarthTouch, Inc. conducted an intensive evaluation of the West Coal Lease Modification Areas.

The results of the cultural resource inventory for the project resulted in the identification of 15 cultural resource sites, which included three previously recorded sites (42SV1301, 42SV1386 and 42SV2688), and 12 new sites (42SV3207-3215 and 42SV3246-3248). Overall, the identified cultural resource sites consist of small- to moderate-sized lithic scatters and small rock shelters/overhangs, some with associated pictographs. Of the 15 sites identified within the West Coal Lease Modification Areas, six sites are recommended eligible for the National Register of Historic Places. These sites include 42SV3209, 42SV3211, 42SV3212, 42SV3213, 42SV3247 and 42SV3248 which consist of small rock shelters and rock shelters with pictographs. Site 42SV3209 will be the only site undermined under the present mine plan. This shelter is more of a terrace overhang that extends 6 meters long, with a 1.5 meter overhang or width.

South Fork of Quitchupah Area of 2R2S Block "A" and 3R2S Block "B"

Cultural and Historic Information. Cultural resource information and maps identifying cultural and historical study areas are located in Appendix 4-2 in the Confidential folder of the M&RP. Canyon Environmental conducted an evaluation of the South Fork of Quitchupah in and adjacent to the 2R2S Block "A" panel Area.

The results of the cultural resource inventory for the project resulted in the identification of 4 cultural resource sites, which included one previously recorded site (42SV2690), and 3 new sites (42SV3462, 42SV3463 and 42S3464). Overall, the identified cultural resource sites consist of lithic scatters and a small rock shelter/overhang. Of the 4 sites identified within the South Fork of Quitchupah Area, two sites are recommended eligible for the National Register of Historic Places.

These sites include 42SV2690 which consists of a lithic scatter and 42SV3464 which consists of a lithic scatter associated with a small rock shelter. Both sites will be undermined under the present mine plan. This shelter is more of a terrace overhang that measures approximately 1.5 meters high and 4 meters wide at the opening and extends 1.5 meters beneath the rock to a tapered edge. The shelter shows signs of modern disturbance and it appears that some of the fill material has been disturbed by minor looting activities.

A cultural resource investigation plan for the 42SV3464 rock shelter was requested and approved between the U.S. Forest Service, Utah State Historic Preservation Office (SHPO), EnviroWest, LLC and Canyon Fuel Company, LLC since the shelter appeared to have been disturbed. Testing of the rock shelter for significance was conducted by EnviroWest and Fishlake National Forest Archaeologist in the fall of 2012. While the site was initially evaluated as being eligible for listing in the National Register of Historic Places, subsequent testing has found it to be ineligible for listing due to disturbance. A copy of the cultural resource investigation testing report and the Determination of Significance and Effect form are located in Appendix 4-2 in the Confidential folder of the M&RP. No further testing of the 42SV2690 lithic scatter was required.

<u>South Fork of Quitchupah Canyon - 2013 Inventory</u> (October 2014)
During July and August 2013 a file search of archeological/cultural resource records and a pedestrian inventory of the study area was performed by EnviroWest LLC. The report is located in Appendix 4-2, Confidential Folder (2013). During the pedestrian inventory five new cultural resource sites were documented, three consisted of lithic scatters located on the bench area and two rock shelters in the canyon. The lithic scatters were recommended by EnviroWest LLC as ineligible for listing in the National Register of Historic Places (NRHP), whereas the two rock shelters were recommended to be eligible for listing in the NRHP. Upon consideration of the EnviroWest LLC report recommendations and a mine plan prepared by Sufco showing several panels to be mined to the north of 3R2S panel a "Determination of Significance and Effect" was prepared by Forest Service Archeologist Charmaine Thompson and signed by SHPO representative in 2013 showing a finding of "adverse effect", Appendix 4-2, Confidential (2013)

Due to a change in Sufco's mine plan and further evaluations by an engineer and geologist it was determined the potential for impact to either shelter by subsidence associated with mining was unlikely. A drawing included in Appendix 4-2, Tension Cracks(2 South) illustrates the location of the shelters in proximity to the 3R2S panel and showed surveyed surface cracks as a result of mining in the 2R2S panel. Evaluation of the cracks from past mining(2R2S, Pines) illustrates that surface cracking associated with subsidence primarily occurs within the mined panel area and well within the anticipated angle of draw of subsidence. Therefore, it is believed that the information and maps provided in Appendix 4-2 demonstrate that the two shelters 42SV3550 and 42SV3551 should not be affected by the mining.

The additional information was provided to Manti-La Sal Forest Service Archeologist Charmaine Thompson. During a second review of the information pertaining to mining activities in relation to the two shelters (Forest Service Project - ML-13-1452, Appendix 4-2) and a visit to the study area, Ms. Thompson revised her earlier determination to be "no adverse effect" to the shelters listed in the report. Ms. Thompson's evaluation letter and determination were forwarded to the Utah State Historical Society, with a request for concurrence with the decision of "no adverse effect", concurrence was given by Chris Merritt, Senior Preservation Specialist. The documentation of the decision and concurrence is located in Confidential Appendix 4-2.

Greens Hollow Tract

The first archaeological survey of the tract area occurred in 2008, and additional survey was conducted in 2009. Twenty-nine heritage resource inventories (including the two previously mentioned) were completed within one mile of the Greens Hollow tract analysis area between 1977 and 2009. Twenty-seven were in association with mining. Over 1,820 acres have been surveyed within the maximum area of potential subsidence. The surveys are highly variable with significanly less surveys being performed in the steeper or more rugged terrain.

There are 18 archaeological sited within the area of the studies, of the sites seven are recommended as eligible for inclusion in the National Register of Historic Places (NRHP). Two of the sites contain rock shelter, the other five are lithic scatters. The remaining eleven sites are not eligible for inclusion in the NRHP. The canyons within the study area will be excluded from mining, reducing the archaeological sites to five with only one of the five being recommended as eligible for inclusion in the NRHP. Refer to Appendix 4-2.

Paleontological resources are expected to exist in the formations within the Green Hollow tract, however no surveys have been conducted. The resources are likely to be of the unprotected variety according to the "Heritage Resource" report in Appendix 4-2.

In accordance with previous commitments the mine has made in previous sections of this M&RP, protection of eligible cultural resources will be in accordance with regulatory authority and Utah SHPO requirements. The Applicant will also instruct its employees that it is a violation of federal and state laws to collect individual artifacts or to otherwise disturb cultural resources.

The Applicant agrees to notify the regulatory authority and the Utah State Historical Preservation Office (SHPO) of previously unidentified cultural resources discovered in the course of mining operations. The Applicant also agrees to have any such cultural resources evaluated in terms of National Register of Historic Places eligibility criteria.

4.1.1.2 Previous Mining Activity

Portions of the mine plan area were mined prior to the filing of this permit application. SUFCO Mine began a small operation mining the Upper Hiawatha Coal seam in 1941. There was no previous mining activity prior to the 1941 SUFCO operation.

From 1941 through 1974, the coal was removed by conventional mining techniques. From 1974 through 1978, both conventional and continuous mining methods were used. From 1978 until October 1985, all mining used continuous mining methods. Since October 1985 both continuous mining and longwall mining methods have been used. The portion of the seam mined by conventional methods was only partially extracted leaving all pillars for support. The majority of the mining done has been full extraction. All longwall mining is full extraction.

The quantity of coal mined prior to this permit application was approximately 37,058,100 tons. The earlier workings are shown on Plate 5-1 as an integral part of the mining operation.

Use of the land preceding mining was primarily grazing. The area also supported limited timbering in the Ponderosa stands and hunting.

4.1.2 Reclamation Plan

4.1.2.1 Postmining Land Use Plan

All uses of the land immediately prior to mining and the capability of the land to support prior alternate uses will remain equally available throughout the life of the mine without impact from underground mining except on insignificant levels. The infinitesimal effect of underground mining on surface use is accounted for as follows:

1. Isolated facilities in use for duration of the mine, including portal and associated buildings, comprise only 48.432 of the 27,605.17 acres under consideration, which is too small to adversely affect general land use.

2. Gradual and even subsidence over most of the lease and permit areas is too imperceptible to affect general land use. The ultimate subsidence affect over the lease will be "uniform." As a qualification, there probably will be an uneven arching effect on the surface over the full-extraction mining areas during actual mining operations which will stabilize in uniform subsidence once the entire area has been mined. The total subsidence effect should be minor so as to not affect general land use.

The Applicant intends that the postmining land uses will be consistent with the land use plans prepared by the Forest Service. 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 those uses required by the U.S. Forest Service land use plans. Retention of pre-SMCRA highwalls is discussed in Section 5.5.3.6.

The SUFCO Mine lease areas are predominantly U.S. Forest Service land managed under the multiple use and sustained yield concepts. Present management emphasizes livestock grazing, wildlife, timber and watershed development.

The land use plans for the lease areas developed by the U.S. Forest Service includes eight different management prescriptions (U.S. Forest Service 1986):

a. Management prescription MMA. Emphasis is on leaseable minerals development. Land surface is to be made available for existing and potential major mineral developments. In units where mineral development is pending, renewable resource activities strive to be compatible with the management goals of adjacent management units. Long-term investments, such as timber planting, generally are not made. However, short-term investments, such as range and wildlife revegetation projects, may be made on these units. As the developments are removed and restoration is completed, these areas may be changed to other appropriate management units.

b. Management prescription TBR. Emphasis is on wood-fiber production and harvest. The harvest methods by Forest cover type are single tree and group selection and shelterwood in Englemann spruce-subalpine fir, Douglas-fir, ponderosa pine, mixed conifers, and clear cutting in aspen. Wildlife habitat diversity may be enhanced by vegetative manipulation. Livestock grazing may be permitted. Water yield could be altered through vegetation management, as well as decrease evapotranspiration and maximize snow retention in small openings on low energy slopes. Dispersed recreation opportunities vary between semi-primitive non-motorized and roaded natural appearing.

c. Management prescription RNG. Emphasis is on production of forage and cover for domestic livestock and wildlife. Intensive grazing management systems are generally favored. Nonstructural restoration practices include a full spectrum of treatments such as plowing, seeding, cutting, chaining, burning, spraying with herbicides, crushing, pitting, furrowing, and fertilization. Dispersed recreation opportunities vary between semi-primitive non-motorized and roaded natural appearing. Management activities are evident, but harmonize with the natural setting.

d. Management prescription GWR. Management emphasis is on providing general big-game winter range. These are areas wildlife traditionally use. Treatments of various types are applied to increase forage production and plant species composition. This may include chaining, cutting, prescribed burning, seeding, spraying, planting, and other treatments. Selected browse species are regenerated to maintain a variety of age classes. Permanent roads and special uses may be permitted. Short-term or temporary roads are obliterated and rehabilitated within one year after intended use. Motorized use is managed as appropriate to prevent unacceptable stress on big-game animals during the primary use season.

e. Management prescription 4B. Management emphasis is on habitat for management indicator species. The goal is to optimize habitat capability, and thus numbers of the species. Investments in other compatible resource uses may occur but will be secondary to habitat requirements. Recreation and other human activities are regulated to favor the needs of the designated species. Roaded-natural recreation opportunities are provided along forest arterial and collector roads. Local roads and trails are either open or closed to public motorized travel. Management activities may dominate in foreground and middleground , but harmonize and blend with the natural setting.

f. Management prescription 6B. Management emphasis is on livestock grazing intensive range resource management is applied. Condition is improved through use of vegetation and soil restoration practices, improved livestock management, and regulation of other resource activities. Dispersed recreational opportunities vary between semi-primitive non-motorized and roaded natural. Management activities are evident but harmonize and blend with the natural setting.

g. Management prescription 9F. Management emphasis is on improving watershed condition. This will be achieved by protection, seeding, cultural treatment or any combination of other methods that will accomplish the objectives. Management activities in the foreground, middleground, and background may dominate, but should be designed to harmonize and blend with the natural setting to the extent possible. Motorized travel is prohibited except for over-snow machines and for designated routes.

h. Management prescription KWR. Management emphasis is on providing key big-game winter range. These areas are essential to wildlife. Motorized use is managed as appropriate to prevent unacceptable stress on big-game animals during the primary use season.

4.1.2.2 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 by the respective Forest Service units for those federal lands that they administer. The private landowner comments concerning the postmining land use are contained in the UNELCO letter in Appendix 1-1.

4.1.2.3 Suitability and Capability

Final fills will not contain excess spoils.

4.1.3 Performance Standards

The performance standards for the areas to be reclaimed for postmining land use are contained in this section.

4.1.3.1 Postmining Land Use

The proposed postmining land uses will be identical to the premining land uses and the land will be capable of supporting such land uses.

4.1.3.2 Determining Premining Uses of Land

The Applicant plans for the same postmining land uses as existed before the operation began.

4.1.3.3 Criteria for Alternative Postmining Land Uses

No alternative postmining land uses have been planned.

4.1.4 Alternative Land Use

No alternative postmining land uses have been planned.

4.20 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.

4.2.1 Air Quality Standards

SUFCO Mine's mining activities are being conducted in compliance with the requirements of the Clean Air Act and the Utah Air Quality Regulations.

4.2.2 Compliance Efforts

The state of air quality control of the SUFCO Mine is generally excellent except the control of fugitive dust in the product loadout area. Watering of this area is done in accordance with stipulations in the Air Quality Permit.

a. Access road - The access road is paved and free of mud and potholes. Access to the road is limited by the surrounding terrain which leaves it free of carried-on mud or dirt by vehicles. Emissions from the access road are minimal.

b. Service area - Fugitive Emissions. The service area is compact and efficient in size and layout. The area in front of the portal and office building as well as the area in front of the shop is paved. Traffic to and from the mine is limited by the small parking area available (approximately 25 car capacity). Personnel are transported to and from the work site by company bus and van pools. Dust emissions caused by personnel and mining support operations are minimal in spite of the partially unpaved parking area. The SUFCO Mine currently employs approximately 234 people. Based-on an average round trip of 62 miles per day, 3.0 million miles of personal car transportation is saved annually by the use of company transportation. This represents an extremely significant limitation of vehicular emissions.

   Fugitive dust emissions from the load out area are moderate. Coal load out operations are the source of most of the fugitive dust emissions. Trucks are routed near the emergency coal storage area. Because some stored material must be loaded with a front end loader, physical separation of the driveway and the storage area is not feasible. Trucks encroach upon the coal storage piles resulting in a thin layer of pulverized coal dust. This emission source is controlled through regular water applications. The area is within the sediment pond collection system.

c. Coal crushing and conveying - All crushing is conducted in closed areas. The main conveyor belts are covered, as are most lifts and drop points. Fugitive emissions observed are extremely low. The low emissions were evidenced even during winds of approximately 15 miles per hour. The extremely good dust control in this area is attributed to the excellent condition of covers and seals and to the relatively high water content of the product.

d. Truck loading - Loading is primarily accomplished by dropping the product from a bin-hopper into the haul trucks. Drop points are well protected from the prevailing wind directions. Loading is accomplished almost immediately after the product is removed from the mine and the water content of the product is assumed responsible for severely limiting dust emissions. Loading of temporarily stored material by front end loader results in significantly increased fugitive emissions. The limited use of this method of loading allows discounting its overall contribution.

The operator controls fugitive dust by application of water to areas where needed. An assessment of the particulate emissions at the mine site are included as Appendix 4-3.

Due to the general excellent air quality and the Pines Tract area's high air mixing, cumulative impacts on the quality of the ambient air are minimal (Pines Tract Project EIS, 1999).

4.2.3 Monitoring Program

The UDOGM does not require an air monitoring program for the SUFCO underground mine at this time. The mine currently operates under Division of Air Quality Approval Order DAQE-AN0106650013-11 SUFCO Mine site dated March 30, 2011 and Small Source Registration DAQE-EN0106590004-11 Waste Rock Disposal Site dated March 31, 2011 found in Appendix 4-4.

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CHAPTER 5

ENGINEERING

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CHAPTER 5

ENGINEERING

5.10 Introduction

This chapter provides a discussion of general engineering aspects, an operation plan, a reclamation plan, design criteria, and performance standards related to the SUFCO Mine. 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 operation and reclamation plans.

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

5.1.1 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.

5.1.2 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 or land surveyors. As appropriate, these persons were assisted by experts in the fields of hydrology, geology, biology, etc.

5.1.2.1 Cross Sections and Maps

Previously Mined Areas. A certified map showing the location of previously mined areas is provided as Plate 5-1.

Surface Facilities. Certified maps and cross sections concerning the disposal of underground development waste are provided in this M&RP, Volume 3. A certified map showing the location of non-coal (non-waste rock) waste storage, coal storage and loading areas, explosive storage and handling facilities, and topsoil stockpiles is provided as Plate 5-2A. An additional topsoil stockpile associated with the waste-rock disposal area is located as provided in Volume 3 of this M&RP.

Locations of sedimentation ponds are noted on Plate 5-2A, 5-2B and in Volume 3 of this M&RP. No water treatment facilities exist at the site other than the sewage leach field, sediment basin, and sedimentation ponds.

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. The durable rock-type construction materials are disposed of in the waste-rock disposal area together with the mine development waste.

Surface Configurations. Certified maps and cross sections showing the final (post-reclamation) surface configuration of the East Spring Canyon disturbed area are provided on Plates 5-3A&B and 5-4. Cut and fill volumes for final reclamation are contained in Appendix 2-5. Information regarding the final surface configuration of the waste-rock disposal areas is provided in Volume 3 of this M&RP.

Hydrology. Certified maps and cross sections associated with the hydrology of the SUFCO Mine area are provided in Chapter 7.

Geology. Certified maps and cross sections associated with the geology of the SUFCO Mine area are provided in Chapter 6.

5.1.2.2 Plans and Engineering Designs

All 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.

Excess Spoil. No excess spoil will be generated from the permit area.

Durable Rock Fills. No durable rock fills will exist in the permit area.

Coal Mine Waste. The design of the waste-rock facility has been certified by a qualified registered professional engineer.

Impoundments. The only impoundments constructed for the mining and reclamation operation consist of sedimentation ponds. Each of these ponds was designed by a professional engineer using current, prudent, engineering practices. These designs were certified by a qualified registered professional engineer.

The existing impoundments within the permit area consist of the four structures constructed for sediment control purposes. These structures are:

- The concrete sediment trap located near the southern end of the mine yard.

- The primary sedimentation pond located immediately below the fill on which the existing mine facilities are constructed.
- The overflow pond located 800 feet downstream from the primary sedimentation pond.
- The sedimentation pond located at the waste rock disposal site.

All pertinent information regarding these sedimentation ponds is presented in Sections 7.3.2.2 and 7.4.2.2.

Primary Roads. The design and construction of the primary road associated with the mine has been certified by a professional engineer as meeting the requirements of R645-301-534.200 and R645-301-742.420. This certification is presented in Appendix 5-1.

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. This certification is presented in Appendix 5-2.

5.1.3 Compliance with MSHA Regulations and MSHA Approvals

5.1.3.1 Coal Processing Waste Dams and Embankments

No coal processing waste dams or embankments exist within the permit area.

5.1.3.2 Impoundments and Sedimentation Ponds

No impoundments or sedimentation ponds in the permit area meet the size criteria of 30 CFR 77.216(a).

5.1.3.3 Underground Development Waste, Coal Processing Waste, and Excess Spoil

No underground development waste, coal processing waste, or excess spoil is disposed of in underground mine workings in the permit area.

5.1.3.4 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 M&RP, Vol. 3.

5.1.3.5 Underground Openings to the Surface

Upon abandonment, each opening to the surface from the underground will be capped, sealed, backfilled, or otherwise properly managed in accordance with 30 CFR 75.1771. Details regarding final abandonment of mine openings are provided in Section 5.4.2.7.

5.1.3.6 Discharges to Underground Mines

No discharges occur from the surface to underground mine workings in the permit area.

5.1.3.7 Surface Coal Mining and Reclamation Activities

No surface coal mining and reclamation activities occur in the permit area.

5.1.3.8 Coal Mine Waste Fires

If any coal mine waste fires occur within the permit area, these will be reported immediately to MSHA and the UDOGM. Immediate remedial action will be taken as deemed necessary by SUFCO Mine to protect public health and safety as well as the environment. Following initial remedial efforts, a long-term plan will be formulated in discussion with MSHA and the UDOGM to extinguish any existing fires and prevent future fires.

5.1.4 Inspections

5.1.4.1 Excess Spoil

Excess spoil is not generated at the SUFCO Mine.

5.1.4.2 Refuse Piles

Regular inspections of the waste-rock area will be made during placement and compaction of the coal mine refuse materials. These inspections will be made by or under the direction of a registered professional engineer experienced in the construction of similar earth and water structures. 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),
- Installation of final surface drainage systems, and
- The final graded and revegetated facility.

The frequency of the inspections will be increased if a danger or harm exists to public health and safety or to the environment. Inspections will continue until the waste-rock area has been finally graded and revegetated.

A certified report will be submitted by a registered professional engineer to the UDOGM within two weeks after each inspection. This report will indicate whether or not the waste-rock pile has been constructed and maintained as designed and in accordance with the approved plan and the R645 rules. The report will also include a discussion of any appearances of instability, structural weakness, and other hazardous conditions noted during the inspection. A copy of the inspection report will be maintained at the mine office.

5.1.4.3 Impoundments

Inspections of all sedimentation ponds associated with the SUFCO Mine will be made at least quarterly. A report of inspection will be prepared by a qualified individual and submitted to the UDOGM within two weeks after each inspection. No other mine-related impoundments exist in the permit area.

New impoundments that may be constructed in the future within the permit area will be inspected regularly during construction and upon completion of construction. These inspections will be made by or under the direction of a registered professional engineer experienced in the construction of similar earth and water structures. Inspections will continue until removal of the structure or release of the performance bond.

All sediment ponds associated with the SUFCO Mine will be inspected annually by a registered professional engineer. A certified report will be prepared by a registered professional engineer and submitted to the UDOGM within two weeks after each inspection. This report will indicate whether or not the impoundment has been constructed and maintained as designed and in accordance with the approved plan and the R645 rules. The report will also include a discussion of any appearances of instability, structural weakness or other hazardous conditions, depth and elevation of any impounded waters, existing storage capacity, and existing or required monitoring procedures and instrumentation, and any other aspects of the structure affecting stability, as noted during the inspection. A copy of the inspection report will be maintained at the mine office.

No impoundments currently exist within the permit area that are subject to 30 CFR 77.216. If impoundments subject to 30 CFR 77.216 are constructed in the future, these impoundments will be inspected on a weekly basis. These inspections will be performed in accordance with 30 CFR 77.216-3.

5.1.5 Reporting and Emergency Procedures

5.1.5.1 Slides

If a slide occurs within the permit area that may have a potential adverse effect on the public, property, health, safety, or the environment, SUFCO Mine will notify the UDOGM by the fastest available means following discovery of the slide and will comply with any remedial measures required by the UDOGM.

5.1.5.2 Impoundment Hazards

If any examination or inspection of an impoundment discloses that a potential hazard is associated with that impoundment that may have an adverse effect on the public, property, health, safety, or the environment, the person who examined the impoundment will promptly inform the UDOGM of the finding and of the emergency procedures formulated for public protection and remedial action.

If adequate procedures cannot be formulated or implemented, the UDOGM will be notified immediately.

5.1.5.3 Temporary Cessation of Operations

Prior to a temporary cessation of operations within the permit area that will last for a period of 30 days or more or as soon as it is known that a temporary cessation will extend beyond 30 days, SUFCO Mine will submit to the UDOGM a notice of intention to cease or abandon operations. This notice will include the following:

- o A statement of the exact number of surface acres and the horizontal and vertical extent of subsurface strata which have been affected by mining operations in the permit area prior to cessation of operations,
- o A discussion of the extent and kind of reclamation activities which will have been accomplished prior to cessation of operations, and
- o An identification of the backfilling, regrading, revegetation, environmental monitoring, underground opening closures, and water treatment activities that will continue during the temporary cessation.

During the temporary cessation, SUFCO Mine will support and maintain all surface access openings to underground operations. SUFCO Mine will also secure surface facilities in areas in which there are no current operations but where future operations are to be resumed under an approved permit.

5.20 Operation Plan

5.2.1 General

5.2.1.1 Cross Sections and Maps

Previously Mined Areas. 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. No previously surface-mined areas exist within the permit area.

Existing Surface and Subsurface Facilities and Features. Plates 5-2A,2B,2C,2D,2E,2F and 5-5 depicts the following information:

- o All buildings in and within 1000 feet of the permit area, including an identification of the current use of the buildings,
- o The location of surface and subsurface features within, passing through, or passing over the permit area, including major electric transmission lines and pipelines (no agricultural drainage tile fields exist within the permit area),
- o Each public road located in or within 100 feet of the permit area,
- o The location of the waste-rock disposal area, and
- o The location of each sedimentation pond within the permit area (there are no permanent water impoundments within the permit area).

Tipple Building was modified in 2008 to widen the tipple building sump to accommodate the use of a larger loader to collect coal fines when the Tipple Building is being cleaned. This allows a loader to collect the coal fines from the Tipple Building cleanup and put them on the coal storage pile preventing them from being washed through the mine yard. Design and cross sections of the Tipple Building Modification are provided on Figures 5-0C and 5-0D.

To facilitate the separation of rock from coal, a rock chute will be attached to the Tipple Building, with a steel girder in a concrete pier (2' X 2' Approx.) atop a spread footing (3' X 3' X 1' Approx.) providing additional stability. The rock exiting the chute will drop into a rock bin constructed of pre-cast 3'X3'x6' concrete blocks. The diagrams of the rock chute structure and rock bin are located in Appendix 5-11. The location of the rock chute footings and rock bin is used for coal storage, preparation and coal loading, making the salvage of topsoil or subsoil unlikely. Excavated material not of a quality to be placed in the coal pile will be hauled and placed with the waste rock.

Landowner, Right-of-Entry, and Public Interest. Plate 5-6 shows the boundaries of lands and the names of present owners of record of those lands, both surface and subsurface, included in or

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contiguous to the permit area. SUFCO Mine has a legal right to enter and begin coal mining operations on all of the lands within the permit area.

Coal mining and reclamation operations are conducted within 100 feet of the right-of-way line of a public road (except where mine access roads join that right-of-way) at the waste-rock disposal area. The measures to be used to ensure that the interests of the public and the affected landowners are protected by operations at the waste-rock disposal facility are outlined in the M&RP, Volume 3.

Coal mining and reclamation operations are conducted within 100 feet of the right-of-way line of the Link Canyon Road, a public-access dirt road. SUFCO Mine uses a portion of this road to access the mining operation's electrical system from the Link Canyon Portal. Mining activities are conducted within 100 feet of this road during maintenance and operation of the electrical substation. The interests of the public and the affected landowners will be protected with respect to this road by the following measures:

- o Surface activities will be conducted in a manner that will not block the road,
- o The portal area access road will be gated and the mine portal intake will be protected from unauthorized entry by the installation of steel sets and a locked chain-link gate. The key for the gate will be kept approximately 25 feet from the gate inside the mine. This permits emergency exit from the mine but prevents entrance from the outside,
- o During initial construction of the facilities the public will be protected by posting warning signs on the road, talking to contractors, and by a temporary chain-link fence with warning sign during portal entrance construction when the contractor is not on site to prevent entrance to the portal, and
- o Regular inspections of that portion of the road are conducted by mine personnel to ensure that erosion does not become a problem. In the event that material damage due to erosion as a result of mining activities is discovered on or along the side of this road, SUFCO Mine will repair this damage and implement additional runoff-control measures as needed.

The mine portals enter the ground beneath the East Side USFS Public Stock Trail, a public-access dirt road that is constructed on the east side of East Spring Canyon from the bottom of SUFCO Mine to the upper plateau. This road has historically been used to herd livestock between grazing allotments during seasonal changes. SUFCO Mine also uses portions of this road to access the mining operation's electrical and water supply systems. Mining activities are conducted within 100 feet of this road during maintenance and operation of the electrical substation and water supply system (adjacent to the road) and where the portals enter the ground (beneath the road). The interests of the public and the affected landowners will be protected with respect to this road by the following measures:

- No subsidence or caving operations will be conducted to affect any portion of the right-of-way of this road within 100 feet of the underground entry system,
- Surface activities will be conducted in a manner that will not block the road, and
- Water bars have been constructed on that portion of the road bordering the disturbed area adjacent to the mine surface facilities. Regular inspections of that portion of the road are conducted by mine personnel to ensure that erosion does not become a problem. In the event that material damage due to erosion as a result of mining activities is discovered on or along the side of this road, SUFCO Mine will repair this damage and implement additional runoff-control measures as needed.

Subsidence from underground mining operations may affect public-access dirt roads throughout the lease and permit areas . As part of the subsidence monitoring program, these roads will be regularly inspected. If material damage occurs to these roads as a result of mine subsidence, the roads will be repaired by SUFCO Mine.

Mining Sequence and Planned Subsidence. The mine plan for the SUFCO Mine is presented in Plate 5-7 (Upper Hiawatha seam) and Plate 5-8 (Lower Hiawatha seam). These maps show the boundaries of all areas proposed to be affected over the estimated total life of the coal mining and reclamation operations, including the size, sequence, and timing of mining of subareas to be affected beyond the present permit term. No surface disturbances are currently anticipated within the permit area beyond that presented in this M&RP.

Plates 5-7 and 5-8 also shows the location and extent of underground workings in which planned-subsidence mining methods will be used as well as areas where measures will be taken to prevent, control, or minimize subsidence and subsidence-related damage. The location of the waste-rock disposal area in relation to the underground mine workings, is discussed in Volume 3 of this M&RP.

Land Surface Configuration. Slope measurements for undisturbed areas adjacent to disturbed areas associated with the mine are shown on Plate 5-2A&B. Surface facilities at the site have been in existence since 1941. Pre-mining topographic maps do not exist. Therefore, the slope measurements shown on Plate 5-2A&B are considered generally indicative of original land slopes in the vicinity of the mine.

Surface Facilities. Plates 5-2A,B,C,D,E,&F and Figure 5-0E shows the locations of the following surface facilities:

- o Buildings, utility corridors, and facilities to be used,
- o The area of disturbance at the mine mouth,
- o Coal storage and loading facilities,
- o Non-coal (non-waste rock) storage areas, and
- o Explosive storage and handling facilities.
- o Portal sites.

The remaining area of land to be affected by mining and reclamation operations is at the waste-rock site. The area of land to be affected at the waste-rock site is shown on maps provided in Volume 3 of this M&RP. The disturbed areas shown on Plates 5-2A,B,C,D,&E and the waste-rock area surface facility maps are the same as the land areas for which a performance bond or other guarantee has been posted.

Locations of topsoil stockpiles are shown on Plates 5-2A, 5-2B and in Volume 3 (Map 2). No coal processing waste banks, dams, or embankments exist in the permit area. Similarly, no spoil or coal preparation waste sites exist in the permit area. Sediment that is periodically removed from the sedimentation ponds will be disposed of at the waste-rock disposal site.

General refuse that is generated on site is stored at the location indicated on Plate 5-2A. This waste consists predominantly of old brattice cloth, ventilation tubing, broken timbers, wire, broken machinery parts, paper, cardboard, and miscellaneous garbage. This non-hazardous, non-toxic, non-coal, non-waste rock refuse is disposed of periodically at the Sevier County Landfill. The agreement with the Sevier County Landfill for disposal of this refuse is provided in Appendix 5-3.

Transportation Facilities. Roads that have been constructed, used, or maintained by SUFCO Mine in the permit area for the mining and reclamation operations are shown on Plate 5-2A&B. No rail systems or overland conveyor systems (other than the material-handling conveyors in the mine yard) are associated with the permit area. Drainage structures associated with the roads are presented in Section 7.5.2.2. Cross sections of the roads are provided on Plate 5-9.

(Figure 5-0E)

Proposed 300,000 Gallon Fire Water Tank Pad Detail

5.2.1.2 Signs and Markers

Mine and Permit Identification Signs. Mine and permit identification signs have been placed at the locations shown on Plates 5-2A,B,D,E,&F. Each identification sign contains the following information:

- o Mine name,
- o Company name,
- o Permanent program permit number as obtained from the UDOGM,
- o MSHA identification number,
- o EPA permit number, and
- o Federal Coal Lease numbers pertinent to the operation.

These signs will be retained and maintained until after the release of all bonds for the permit area.

Perimeter Markers. Perimeter markers (disturbed area boundary) have been installed at the locations shown on Plates 5-2A,B,C,D,E,&F. These markers, consisting of red and yellow steel T-posts, delineate the areas affected by surface operations at the mine. Each perimeter marker can be seen from the ground connectively from another marker.

Buffer Zone Markers. Stream buffer zone markers have been placed at the three locations within the permit area where surface effects of mining activities approach perennial or intermittent stream channels. These locations are as follows:

- o Quitchupah ventilation entries located adjacent to the North Fork of Quitchupah Creek in S 1/2 Sec. 29, T. 21 S., R. 5 E.
- o The vicinity of the pump station and leach field near the confluence of East Spring Canyon and Quitchupah Creek in S 1/2 Sec. 12, T. 22 S., R. 4 E.
- o The vicinity of the Link Canyon Portal in SW 1/4 NW 1/4 Sec. 26, T. 21 S., R. 5 E.

Each buffer zone marker has dimensions of 12 inches by 18 inches and is labeled "Stream Buffer Zone - No Disturbing Beyond This Point".

Topsoil Markers. Markers have been placed on all topsoil stockpiles. These markers are labeled "Topsoil Storage Area".

5.2.2 Coal Recovery

Current mining operations at the SUFCO Mine occur in the Upper Hiawatha Seam. Future mining operations are also planned to occur in the Lower Hiawatha Seam. The overall objective of mining operations in the lease and permit areas is to maximum coal recovery coupled with safety. Coal recovery at the mine has been and will continue to be maximized through the following efforts:

- o Pre-mining analysis of drill-hole data allows estimates to be made of the nature, depth, and thickness of the coal seam and associated partings. Using these data, the mine plan and mining methods are evaluated and amended as necessary to maximize coal recovery.
- o Experience gained during mining is used to amend future mine plans if coal recovery can be increased.
- o The mine converted from an exclusive room-and-pillar extraction method to a combination of room-and-pillar and longwall extraction methods in October 1985. As a result of this conversion, coal recovery at the mine increased from approximately 75 percent under exclusive room-and-pillar methods to 88 percent under the combined room-and-pillar and longwall methods.

The mine layout has been planned relative to panels, barriers, and pillars to optimize both coal recovery and safety using a combination of longwall and room-and-pillar mining techniques.

An evaluation of geologic data collected in the southern portion of lease U-28297 indicates that the Upper Hiawatha seam in this area contains a paleochannel system and associated parting. The parting attains a thickness in excess of 20 feet and occurs in a northeast-southwest trending band varying in width from 2,000 feet to 7,500 feet. Because of this parting, most of the southern portion of lease U-28297 is deemed unminable from both technological and economic viewpoints.

Mining is not planned on the extreme east and southeast portions of the Pines Tract Lease UTU-76195 as a result of poor quality and seam height. A parting located in the middle of the seam, will not allow mining to occur at the minimum height without putting quality at unacceptable levels. Much of the seam height in these areas is between 4-6 feet. Reserves are also lost to burn in these areas as a result of several promontories in the area which allow greater exposure of the outcrop to the atmosphere.

Mining is not planned on the northern portion of the SITLA Muddy Tract Lease ML 49443-OBA in the Upper Hiawatha Seam as a result of a sand channel and seam height that will not allow mining to occur.

The Lower Hiawatha seam will be mined in the northwest portion of the lease area where the interburden thickness between the Upper and Lower Hiawatha seams exceeds 30 feet. The mine plans are columnized or stacked where both seams are to be extracted. The Duncan seam does not contain sufficient minable reserves to warrant mining within the lease area.

The Duncan seam occurs about 100 to 130 feet above the Upper Hiawatha seam in a small portion of lease U-28297. The unsplit area of the Duncan seam is of small extent, probably less than 50 acres. Federal Lease U-28297 grants Canyon Fuel Company, LLC SUFCO Mine only the right to mine the Upper Hiawatha seam.

The Quitchupah Tract Resource Recovery and Protection Plan (R2P2) for Canyon Fuel Company, LLC SUFCO Mine is on file with the Bureau of Land Management. The R2P2 contains detailed mine plan and reserve calculations for all of the Quitchupah Tract leases operated by Canyon Fuel Company, LLC SUFCO Mine.

The Pines Tract Resource Recovery and Protection Plan (R2P2) for Canyon Fuel Company, LLC SUFCO Mine is on file with the Bureau of Land Management. The R2P2 contains detailed mine plan and reserve calculations for the Pines Tract lease operated by Canyon Fuel Company, LLC SUFCO Mine.

The SITLA Muddy Tract Plan of Operations Resource Recovery and Protection Plan (R2P2) for Canyon Fuel Company, LLC SUFCO Mine is on file with the State of Utah, School and Institutional Trust Lands Administration. The Plan of Operations Resource Recovery and Protection Plan (R2P2) contains detailed mine plan and reserve calculations for the SITLA Muddy Tract lease operated by Canyon Fuel Company, LLC SUFCO Mine.

5.2.3 Mining Methods

A combination of room-and-pillar and longwall mining methods are used in the SUFCO Mine. The use of these two mining methods has been selected to maximize coal recovery and enhance production rates within the specific geologic constraints of the lease area.

Room-and-Pillar Mining. Room-and-pillar mining is conducted at the SUFCO Mine using continuous miners for the following purposes:

- To develop the mains, submains, and panel entries,
- To extract panels where the cover is 1,500 feet or less,
- To partially extract coal in areas where surface features require protection, and
- To extract coal in areas where geological conditions or physical boundaries are not suitable for longwall mining.

Panel development under room-and-pillar mining methods is achieved by driving three panel entries from the main entries along side the designated panels. Each mining panel is then developed from these entries on the retreat. Pillars within panels that are not required to remain in place to protect long-term mine access or surface resources are also extracted upon retreat from an area to increase coal recovery.

Coal is transported from the continuous miner to the belt feeder by electric or diesel haulage units. Coal is conveyed out of the panel and on out of the mine by belt conveyors. Diesel-powered, rubber-tired tractors and service cars are used to transport personnel and materials from the portals to the working faces.

Pillars in developed entries will be left to protect adjacent panels.

Longwall Mining. Longwall mining is used for extraction of large, uniform blocks of coal where the panels are more than 2,500 feet in length and where a suitable longwall panel can be laid out. Coal thicknesses of up to 14 feet are mined in the SUFCO Mine using longwall methods. In areas where coal is thicker than the height capacity of the mining equipment, the unmined coal will be left on the bottom of the bed unless economic or safety conditions warrant otherwise.

The longwall mining system at the SUFCO Mine consists of three basic integrated sub-systems: self advancing roof support, shearer, and conveyance. Shield-type roof supports are used. Shield supports are generally considered more suitable for mining conditions such as those encountered at the SUFCO Mine and are designed for expansion, contraction, advancement, and movement in varying thicknesses of coal.

The longwall shearer at the SUFCO Mine utilizes a double-ended shearer system for efficiency and flexibility of operation. Such a system consists of two rotary cutting drums mounted on ranging arms which are pivoted to a common body containing the power and drive assemblies. An optimum-tip drive speed is associated with each drum-pick configuration and diameter to assure minimization of fines in the sheared coal. The conveyance system used in the mine has been designed to convey extracted coal along the 540 to 1000 foot faces.

Anticipated Production. Anticipated annual production of coal from the SUFCO Mine during the permit term is a follows:

2015 - 6.5 million tons

2016 - 2020 coal production will range from 5.8 thru 6.5 million tons

Through the remaining life of the mine, coal production from the mine is anticipated to be 4.85 million to 8.0 million tons per year.

Major Equipment. Major equipment in use at the SUFCO Mine is listed in Table 5-1. The same type of equipment or equivalent is expected to be used in the future.

TABLE 5-1

List of Major Equipment

Type of Machinery	Manufacturer	Model Number
Cutting Machine	Joy	15RU
Continuous Miner	Joy	12CM-12
Coal Drills	Long-Airdox	RDF-24
Roof Bolters	Lee Norse, Fletcher	T1-43, HDDR-13
Roof Bolters	Secoma	PEC-22M-1BR-D4
Shuttle Cars	Wagner / Joy	MTT-F20-S18, MTT-F17-I45 / 10SC32
Front-End Loaders	Eimco	913, 915D, 915E
Front-End Loaders	Wagner	ST2D
Feeder Breakers	Stamler / McLanahan	14B / HV56
Feeder Breakers	Long-Airdox	R11
Compressors	Gardner-Denver	185 CFM
Rock Dusters	MSA	400
Mantrips	Getman / Dodge	R62 X PC / RAM 3500
Longwall Shearer	Joy	7LS
Longwall Shields	Joy	960 Ton
Stage Loader	MTA	---
Face Conveyor	MTA	
Crusher	MTA	
Mobile Tailpiece	Joy	---

5.2.4 Blasting and Explosives

Mining and reclamation activities at the SUFCO Mine generally does not require the use of blasting or explosives on the surface. Historically the infrequent surface blasting conducted at the SUFCO Mine has been for construction projects and for removal of dislodged boulders that roll into the surface facility area. These blasts have been under the 5 pound exemption in most cases, and have been conducted under the direction of a certified blaster. Any future blasting associated with mining and reclamation activities that may be needed will be conducted in accordance with R645-301-524. All underground blasting activities at the mine are conducted under the direction of a MSHA certified blaster.

5.2.5 Subsidence

SUFCO began operations which caused surface subsidence in June 1976. At that time, continuous miners were used to extract coal from pillars which were developed as part of a retreating panel. The panels were approximately 650 feet wide and varied in length up to 2,500 feet. The average mining height in this initial area of pillar extraction approached 11 feet and the extraction ratio averaged about 80 percent.

The resulting subsidence from the initial retreat mining averaged about 4 feet in plateau areas where the overburden was approximately 900 feet thick. In areas where panel boundaries were outside the escarpment created by (i.e., not overlain by) the Castlegate Sandstone, subsidence increased with the decreasing overburden thickness and the decreasing strength of the overlying rock. The maximum subsidence in this first area of pillar extraction was 8.5 feet in an area not overlain by the Castlegate Sandstone where the overburden thickness was only about 600 feet.

Longwall mining was introduced at the SUFCO Mine in October 1985, when a longwall system was added. Longwall panels have ranged in width from 540 feet to 1000 feet and up to 17,000 feet in length. Mining heights have varied from 8.5 feet to 13.5 feet with the longwall system.

Subsidence above the longwall panels has historically averaged about 4 feet. Overburden thickness above the longwall panels has typically been greater than above the room-and-pillar panels. The maximum subsidence caused by longwall mining to date has been 7 feet.

Several draw angle surveys have been performed at the mine over the past fourteen years. These surveys have been oriented both parallel and perpendicular to the long axis of the panel. Data collected over continuous-miner areas to date indicate that the average draw angle is 15 degrees. Individual measurements over continuous-miner areas have ranged from 10 to 21 degrees. New longwall draw angle data obtained in 1995 indicates an angle of 15 degrees for the longwall areas. Draw angle study completed in 1999 over 13L4E LW panel indicates 15 degrees is valid. Summary results of the LW panel studies are shown in Figures 5-0A and 5-0B.

Tension cracks have occurred over most of the subsidence areas. These cracks tend to be most pronounced in areas where pillars have been extracted (as compared to areas overlying longwall panels). The lengths of the cracks vary from a few feet to nearly 200 feet. Most are oriented either parallel to the natural jointing pattern or parallel to the boundaries of the underground excavation. Cracks with the longest continuous length appear to be natural joints which have been intensified by subsidence action. Vertical displacement along the cracks is uncommon and horizontal displacement varies from hairline to several inches in width. Follow-up observations of individual tension cracks indicate that the cracks tend to close (either partially or fully) following initial development (see Appendix 5-4).

Monitoring data collected to date indicate that subsidence above the SUFCO Mine occurs rapidly after initial movement. Approximately 80 percent of maximum subsidence occurs within about four months. The remainder of subsidence occurs slowly over a period of a few years. These monitoring data have been presented and summarized annually in reports submitted to the UDOGM by SUFCO Mine.

5.2.5.1 Subsidence Control Plan

Potential Areas of Subsidence. Structures that are present above the existing or planned mine workings that may be affected by mining are shown on Plate 5-5. Renewable resource lands within the lease and permit areas are shown on Plate 4-1.

(Figure 5-0A)

14L4E Draw Angle Study

(Figure 5-0B)

6 East Draw Angle Study

Mining Methods. As noted in Section 5.2.3, both room-and-pillar and longwall mining methods are used in the SUFCO Mine. The size, sequence, and timing for the development of the underground workings are shown on Plates 5-7 and 5-8.

Physical Conditions Affecting Subsidence. A detailed description of the physical conditions in the lease and permit areas that influence subsidence (i.e., overburden lithology and thickness, coal seam thickness, etc.) is provided in Chapter 6.

Subsidence Control Measures. Most of the land within the lease area will eventually be affected by subsidence. Anticipated areas of subsidence and those areas planned for protection from subsidence are shown on Plates 5-10A, 5-10B & 5-10C. The primary areas where subsidence is not anticipated are the areas overlying the pre-1977 workings in Lease SL-062583 shown on Plate 5-1 (referred to herein as the "Old Mine") and certain lease areas underlying Quitchupah Canyon, Box Canyon, and Muddy Creek.

The "Old Mine" area was mined in such a manner that coal pillars were left for support throughout the entire workings. Since these pillars are large enough to support the overburden and further mining is not anticipated in these workings, the surface area above the workings should not experience any subsidence.

Where perennial streams are not undermined they will be protected from subsidence by establishing stream buffer corridors within the mine from which only limited coal recovery will occur. Support pillars will be left in these locations to preclude subsidence. Underground stream buffers will only be crossed to the extent necessary to allow access to reserves. This access will consist of entries and cross cuts with support pillars. Entries that cross through the underground stream buffer corridors with less than 300 feet of cover will be sealed and/or backfilled upon abandonment using the best available technology to prevent disturbance of the overlying streams.

Protected cultural resource sites (see Plates 5-10AC, 5-10BC & 5-10CC located in the Sufco Mine MRP Confidential file) will be designed to include a buffer zone to protect the area from the effects of subsidence caused by underground full extraction mining. The width of the corridor will be calculated as follows: the depth of overburden to the coal seam will first be established. This depth will be multiplied by tan 15° to obtain the distance underground mining needs to be away from the area to not cause subsidence effects. An additional 25 foot buffer will be added to this calculated distance to account for minor irregularities in the course of the stream or cultural resource site.

Surface structures overlying the area to be subsided consist of trails, unimproved dirt roads, fences, runoff catchment ponds, and streams. The applicant will repair any subsidence caused damage to these or other structures to the extent economically and technically feasible, and will comply with R645-301-525.160 and R645-301-525.230. Additional mediation and remedial measures are described in Section 5.2.5.2 Subsidence Control.

Monitoring within the lease area has shown that subsidence rarely exceeds 50 percent of the mining height where the overburden thickness is greater than 800 feet. This overburden thickness is generally achieved above the rim of the Castlegate Sandstone (see Plates 5-10A, 5-10B & 5-10C). Topography above the Castlegate Sandstone is gently sloping while that within and below the sandstone outcrop contains cliffs and steep slopes. With the exception of the experimental mining practice described below, future subsidence is typically planned only for those areas above the rim of the Castlegate Sandstone where the overburden thickness exceeds 800 feet.

Experimental Mining and Subsidence. To protect the environmental resources associated with escarpments, SUFCO Mine currently has a general policy of precluding subsidence below the rim of the Castlegate Sandstone. This requires that significant quantities of coal remain unrecovered.

Pillars were extracted from room-and-pillar workings beneath two areas of escarpment. The location of these areas is shown on Plate 5-1. These areas involved a 5,000-foot section of escarpment on Federal lease (SL-062583) in East Spring Canyon (1977-78) and 2,000 feet of escarpment on Fee property (1983-88) on the east side of Quitchupah Canyon. The East Spring Canyon escarpment is much less distinct than the Quitchupah Canyon escarpment due to the greater depth of Quitchupah Canyon.

Following pillar removal from the East Spring Canyon area, tension cracks were found around the perimeter of the canyon. Most of these cracks followed natural joints which were temporarily amplified by subsidence. There were no slope or cliff failures along the entire 5,000 feet of affected escarpment.

A similar pattern of tension cracks occurred above three room-and-pillar panels in Quitchupah Canyon. There were no slope failures, but one incidence of cliff spalling occurred.

Longwall mining was first implemented by SUFCO Mine in 1985 in areas that would not affect the escarpments. Observations during the next two years indicated that, unlike room-and-pillar extracted areas, subsidence in areas overlying longwall panels did not cause significant tension cracking that might result in massive slope failure if the cracking was to occur along the escarpments. With this in mind, and with the goal of both SUFCO Mine and the land management agencies being to maximize coal recovery while minimizing environmental impacts, an experimental project was requested by SUFCO Mine and approved by the UDOGM in 1987 (see Appendix 5-5). Under this program, a section of Quitchupah Canyon below the Castlegate Sandstone escarpment was included in the planned longwall subsidence zone. The purpose of this project was to determine whether or not an escarpment could be undermined by longwall mining with minimal or no surface effects.

Prior to mining in the experimental areas, a raptor survey was conducted of the cliff areas on both the west side of Quitchupah Canyon where the mining was to occur and the east side of the canyon opposite the mining section. A visual and photographic survey was also performed of the experimental area to document pre-mining conditions. Pre-mining subsidence monitoring stations were established above the experimental panels to provide future survey control. These stations were installed in high and low tension areas around the escarpment and near naturally-eroded blocks of sandstone that were standing independent of the cliff face.

Three longwall panels were completed in 1987 as part of the project. The area of proposed escarpment subsidence (the "Experimental Mining Practice" area) is shown on Plate 5-1. The north ends of two of the longwall panels extended beyond the escarpment toward the canyon. The third longwall panel was located entirely beyond the cliff beneath the canyon wall.

To date, monitoring efforts associated with the experimental mining practice have established that subsidence has occurred in a predictable manner varying from one foot to seven feet with minimal surface disturbance. One of the independent sandstone blocks fell from the escarpment during subsidence and a few tension cracks were created along the cliff face. No other visible signs of mining were found even though the surface elevations have dropped several feet in some areas of the experiment. Monitoring stations have moved horizontally from a few tenths of a foot to nearly three feet. Post-mining monitoring of the surface above the longwall panels is continuing. A report which describes the experimental project and its results in greater detail has been prepared for submittal to the UDOGM.

Subsidence Monitoring. In 1976 (i.e., prior to the onset of subsidence), SUFCO Mine began collecting baseline topographic data from the lease area using conventional survey methods.
The use of conventional survey methods for subsidence monitoring continued until 1985 (i.e., at the beginning of longwall mining), when the lease area was flown to establish a set of baseline photography and a grid of surface elevations. Where possible, elevations were photogrammetrically determined from this baseline photography on an approximate 200-foot grid. These original horizontal and vertical data, together with the original conventional-survey data, serve as the comparative database for determining ground movement in subsequent years. A baseline was also established to monitor changes in vegetative cover with the use of color infrared aerial photography (CIR). The first baseline was done in 1987 for the existing leases. The baseline for the Quitchupah lease was flown in 1988 with CIR. The applicant will follow up with CIR coverage of the leases at least every five years. The CIR photographs are stored at the SUFCO Mine. CIR photography was taken in 1990, 1995, 1999, 2003 (East Fork Box Canyon only), and 2004. The next projected CIR flight dates will be in 2008, 2013, and 2018.

Additional aerial photography of the lease area is currently obtained on an annual basis. New elevations are then determined at each of the previously-selected horizontal coordinates and the differences between the original and the new elevation measurements are used to generate a subsidence contour map. This map and supporting narrative are submitted annually to the UDOGM in the form of a subsidence report. This subsidence report outlines the history of subsidence at SUFCO Mine as well as the status of subsidence during the previous year.

Numerous control points have been established within the lease area to assist in the subsidence surveys (see Plates 5-10A, 5-10B & 5-10C). Current (2005) coordinates and elevations of these control points are provided in Table 5-2. Additional control points will be added as necessary when existing points become influenced by subsidence. Future points will typically consist of 3-foot lengths of No. 4 rebar embedded in concrete with a stamped brass cap for identification. Since geologic and mining uncertainties often force a change in planned mining sequences, future control points will be installed only after the mine panels are in their development phase.

All subsidence areas will be monitored and reported in the Annual Subsidence Report for a minimum of three years after no additional subsidence is detected within the area. The applicant will map and report areas 3 and 4 in the 1993 Subsidence Report as required by Division Order #93A issued May 11, 1993.

A annual monitoring program was developed to analyze the subsidence cracks related to undermining of the West Fork of Box Canyon. Mining in the area in 1999 did produce visible fracturing at the surface on both the northwest and southeast walls of the canyon in this area. The monitoring program includes measuring the offset and/or width of portions of selected subsidence cracks. Similar data will also be collected from specified segments of subsidence cracks that have occurred away from the walls of the canyon and do not appear to be influenced by the lack of bedrock support created by the canyon. Information gathered from this monitoring program, along with previous studies that SUFCO has performed, will be used to predict the effects of subsidence within other areas of the Pines Tract and other areas of the bedrock support created by the canyon. Information gathered from this monitoring program, along with previous studies that SUFCO has performed, will be used to predict the effects of subsidence within other areas of the Pines Tract and other areas of the

TABLE 5-2

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
1	100933.10	100609.71	7315.34
2	100565.70	103173.88	7149.08
3	099076.69	105831.18	7131.86
4	098827.15	109182.36	6838.11
5	097739.92	112429.91	6652.60
6	098187.90	115780.06	6710.89
7	101987.39	112752.20	8554.88
8	105324.02	101281.04	8315.50
9	103998.64	105465.03	8442.60
10	106048.81	106874.81	8474.26
11	106083.32	109335.63	8546.47
12	106407.15	112616.26	8585.45
13	106926.38	115554.92	6988.22
14	112526.11	106273.15	8443.36
15	112910.14	111586.69	8563.16
16	109957.72	113812.10	8518.59
17	116847.53	102937.28	9003.88
18	116733.24	104654.99	8901.47
19 (Revised)	120799.68	100165.13	8564.78
20	121554.78	103088.64	8269.06
21	121925.97	106488.16	8314.80
22	123340.78	106906.63	8265.83
23	122238.22	110529.04	8324.02
24	122771.92	112735.33	8378.90

TABLE 5-2 (Continued)

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
25	123102.30	115175.43	8422.27
43	120606.40	096818.38	8881.35
46	131953.05	096842.20	8967.40
47	131406.54	099790.56	8735.34
48	129564.58	105575.88	8211.58
49	133890.19	103488.80	8895.50
50	134292.38	106557.44	9126.18
52	133973.27	112700.74	8892.11
53	133972.65	116076.79	8582.82
55	133461.40	122392.99	8389.42
57	122796.10	125334.72	8596.38
58	119334.36	118753.61	8611.35
59	112742.29	118595.02	8251.06
60	112677.39	121836.63	8657.35
61	113581.19	125314.33	8711.65
62	115900.60	125001.09	8664.19
65	122998.42	100043.41	8275.61
67 (Revised)	120400.21	125572.86	7658.25
68	121008.54	128517.80	8667.51
69	121064.58	131691.97	8720.08
70	123166.59	128582.95	8637.33
71	121965.02	131669.43	8748.82

TABLE 5-2 (Continued)

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
72	121091.97	134835.59	8810.09
73	130940.23	125235.97	8435.89
74	131206.85	128568.20	8474.85
75	128197.83	131572.43	8631.51
76	128706.03	134833.56	8705.02
77	138653.63	119486.03	8412.87
78	136770.99	122164.99	8341.95
79	137042.30	125376.08	8409.73
80	138131.90	128567.68	8420.98
81	137335.10	131613.73	8469.17
82	136757.67	134767.91	8595.58
83	145161.90	119006.17	8502.03
84	145310.24	122168.20	8379.41
85	145393.67	123937.67	8446.34
86	145687.89	126377.39	7222.27
87	145520.70	128446.66	7170.99
88	143117.38	131943.66	7115.53
89	140965.75	134680.45	6913.76
90	138349.45	123503.97	8350.67
91	140360.60	103418.30	9243.20
92	142200.39	106446.97	8784.97
93	140543.29	106496.64	8835.50
95	142287.36	112714.35	8157.58

TABLE 5-2 (Continued)

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
96	142129.47	115804.45	8323.47
Target S-01	134412.69	109928.67	9099.23
Target S-02	142127.65	118654.01	8278.10
Target S-03	131206.75	128568.49	8474.79
Target 101	142259.06	109602.00	8552.72
Target 102	140976.06	129707.23	8536.62
Target 103	137042.33	125376.45	8409.71
Target 104	137335.16	131613.94	8469.01
Target 105	133222.00	119010.95	8401.37
Target 106	130239.16	124047.60	8405.61
Target 107	126214.50	109707.88	8269.56
Target 108	124851.64	120918.64	8513.89
Target 109	123283.19	122424.39	8685.95
Target 110	124577.10	133135.31	8756.13
111	131435.14	093398.98	9483.95
112	101809.44	93166.11	8206.73
113	109138.83	97006.51	8256.40
114	120548.07	094938.16	8918.07

TABLE 5-2 (Continued)

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
4 Pines	134940.98	111950.24	9104.90
AcordLake	100330.43	86378.77	8031.46
All Day	124415.20	137279.51	8794.23
Alpine	122693.58	133912.37	8775.10
Baldy	106802.50	110566.59	8624.03
Bare Hill	136907.89	128650.98	8473.07
Barrier II	121546.60	110839.05	8359.58
Bart	132531.22	123248.44	8411.34
Blue Blob	129058.58	129542.30	8558.89
Bonnie	122603.34	118617.66	8580.47
Boulder	136741.64	121487.39	8391.12
Bud	127964.99	107186.72	8231.78
Bull	126376.68	110388.37	8298.63
Burn Out	138040.85	129607.77	8452.15
Butte	119468.45	107824.97	8513.92
By Ricci	145238.72	128819.35	7195.57
Castlegate	120940.28	111188.85	8366.35
Chimney Rock	130171.29	128312.17	8490.07
Chips	119943.68	113401.39	8419.17
Clay	136358.77	115069.31	9095.57
Cliff Edge	140641.19	130336.85	8434.25
Cow Trail	102478.62	108301.73	8524.99
Creek Hill	141988.81	133601.71	7018.19
Crossroad	121135.78	133856.06	8813.10

TABLE 5-2 (Continued)

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
Days End	125053.71	133352.20	8780.04
Dead Pine	118532.28	108623.09	8394.25
Duncan Peak	117641.30	099157.75	9255.24
Eagle	118292.79	113692.02	8433.71
Elk	112136.88	099467.17	8531.54
Everest	130826.10	097165.08	9029.84
Extra	138911.86	128161.89	8443.67
Fallen Pine	121845.42	125226.35	8619.66
First Time	120266.36	111722.00	8366.61
Forgot	129137.52	130560.75	8577.72
Freeway	125720.33	112564.03	8315.36
Garbage Can	102175.31	101467.61	7561.08
Gizmo	122137.04	129822.89	8673.16
Gnat	097162.73	111116.78	6716.70
Gobbler Gulch	121232.03	129666.98	8671.22
Grassy Knoll	145457.82	120897.55	8597.82
Green River	136951.77	124862.48	8505.73
Grouse	125780.48	117184.19	8484.19
Guard Shack	102480.18	101499.92	7552.14
Hail	123389.21	128574.54	8642.14
Head East	123040.13	129598.25	8665.50
Hidden	117192.48	110476.66	8425.89
Highland	144495.99	119415.42	8659.16
Hillcrest	124080.42	133992.88	8818.92
Hill Top	136802.66	133597.53	8722.09

TABLE 5-2 (Continued)

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
Hurry	125665.00	106492.42	8509.89
Jack Adley	105747.68	103040.36	8432.07
Jasen's Nest	132934.62	125327.45	8554.30
John's Rock	123848.46	134651.07	8828.95
Juan	123386.14	119603.88	8523.10
Justified	128683.85	133693.88	8709.89
Just Short	130862.41	128497.71	8483.68
Last Chance	115892.42	110035.39	8645.18
Link View	119626.35	123890.93	8644.73
Little Duncan	112480.42	109271.23	8990.15
Little Pine	120626.81	122034.00	8770.46
Lucky	097058.75	113724.52	6595.87
Marcy	100342.33	104808.45	7061.46
Meatloaf	134988.07	125832.28	8479.53
Midway	128483.90	121492.16	8458.22
Mineroad1	100290.94	096964.02	7577.04
Moe	143714.16	118339.95	8360.98
Mortensen Point	101559.99	101384.00	7571.94
Mountain Mahogany	133803.19	114797.44	8592.09
Muddy Rim	145288.54	124311.74	8328.19
Muddy Vista	145902.97	120205.73	8576.45
Murphy	119417.11	114774.23	8572.64
Nancy	124336.00	124784.76	8778.71
No Name	124961.47	107615.96	8304.06

TABLE 5-2 (Continued)

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
Oak	115633.20	110789.61	8468.06
Old Road	128492.07	115262.29	8456.61
One Jump	116111.78	115519.96	8536.01
Oscar	111252.09	103359.60	8414.10
Over Time	122088.93	114328.74	8464.99
Paintbrush	136700.67	125597.47	8420.74
Pine Grove	120940.90	128889.96	8683.13
Pine Hen	115127.26	099989.31	9001.95
P.K. Nail	118833.45	109123.60	8380.36
Pot Hole	108988.85	099782.73	8294.55
Prairie View	131204.98	125857.42	8451.01
Rain Gauge	102916.00	101948.87	7558.53
Rain Rock	121342.03	130240.93	8691.08
Ramble On	121927.63	131923.04	8758.11
Range Pole	125342.96	113084.37	8356.94
Rattle Snake	105717.67	105315.88	8411.86
Red Nose	111823.28	124354.97	8667.55
Ridge	117278.21	107079.21	8630.86
Rim Rock	102804.40	100422.90	8367.60
Rocknest	144458.05	129952.07	7154.21
Rock On	122072.13	131499.36	8738.41
Rocky II	126969.22	109539.79	8320.28
Sage	128102.11	134164.59	8718.55
Sandhill	122060.12	134109.81	8811.25
Sandridge	121328.27	127907.98	8648.74

TABLE 5-2 (Continued)
Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
Scales	103185.47	101587.37	7548.18
Sedpond1	102002.12	101463.23	7562.73
Shady Pines	125570.58	133937.70	8766.82
Single Tree	131237.84	127470.34	8460.00
SKS	123193.35	135241.06	8832.12
Slab Rock	119915.33	104763.90	8549.06
Slaughter Hill	144554.25	122928.40	8560.94
South Fork	122360.32	102147.28	8217.44
Spike	106426.93	100039.17	8325.62
Split Rock	129534.95	128829.31	8519.39
Standard	133589.26	108900.52	9139.56
Stock Pond	132382.89	118400.29	8390.90
Stonewood	121550.07	134283.71	8815.21
Stumpy	127542.00	131932.07	8660.21
Substation B.M.	102787.93	102081.34	7563.46
Sunspot	122068.81	130374.08	8705.83
Switchback	120172.62	126162.50	7826.13
Terrace	103533.00	101612.28	7598.64
That	134704.05	121439.83	8354.24
This	133853.23	122161.75	8385.37
Three Pines	128994.27	131195.32	8610.37
Thunder Ridge	145713.29	121585.36	8502.52
Two Flats	121612.91	132938.78	8783.19
U.S.G.S.	130065.44	100406.72	8648.16
Valley View	115797.62	099307.50	9054.37

TABLE 5-2 (Continued)

Subsidence Control Point Survey Data

Station Name	Northing	Easting	Elevation
Vanwinkle	120967.82	131485.30	8738.62
Wasatch2	176502.69	091318.15	11130.23
White Rocks	119944.80	116486.58	8530.16
White Rocks II	119945.83	116485.02	8526.53
Wilco	120846.31	129130.30	8685.09
Wildcat	121403.85	122435.42	9030.03
Wileys	130032.60	134664.80	8652.51
Window	125525.90	111439.67	8290.13

mine where similar geomorphologic and geologic conditions occur. This program was developed and implemented by the Fall of 2000. Subsidence cracks in the area of the West Fork of Box Canyon were surveyed for their location. However, in the years 2000 through 2003 the width and/or offset of the cracks were not measured or the records were not kept. Width and/or offset measurements were made in the Fall of 2004 and will again be made in the Fall of 2005 and every year thereafter. It is believed by the permittee that any change in the width of the cracks can easily be tracked on an annual basis rather than a semi-annual basis. The permittee has observed that most subsidence cracks that develop in the mining area do not change significantly after the first 4 to 6 months following their creation. The crack measurement records will be reported in the mines annual report. Subsidence cracks in the area of the West Fork of Box Canyon are located in Longwall area 10 that has been mined out since 2001, and the area is now assumed to be dormant. 2008 will be the last year these cracks will be monitored since there will not be anymore movement in this area.

Anticipated Effects of Subsidence. Future subsidence in the lease area is anticipated to be similar to that which has occurred in the past. Subsidence is expected to average about 4 feet above longwall panels, with a draw angle of about 15 degrees. Tension cracks are expected to occur in areas of subsidence with these cracks healing to some degree following formation. Tension cracks are anticipated to be less pronounced above longwall workings than above continuous-miner workings.

Previous surveys have indicated that no substantial damage has occurred to vegetation as a result of subsidence within the lease area. The only effects observed have been exposed plant roots where tension cracks have formed.

It is anticipated that subsiding under portions of East Fork Box Canyon and South Fork Quitchupah will result in a slight flattening of the stream gradient, which will increase pooling of the stream through a stretch of several hundred feet of the stream. Cracks will also likely develop across the East Fork Box Canyon Creek directly above the longwall panels and along the gate roads. These crack zones will form shortly after undermining of the stream bed. They are anticipated to be 1 to 2 inches or less in width with these cracks healing to some degree following formation. Details of

2 inches or less in width with these cracks healing to some degree following formation. Details of the expected location of the cracks are given in Appendix 7-19. Because of the nature of the fine-grained sediments that form the stream channel floor in the South Fork of Quitchupah, surface cracks - if any form - are anticipated to be very narrow in width and would self heal rapidly. However, if cracks do develop in the channel floor and appear to be taking surface water from the creek, sealing of these cracks will be done with bentonite grout. Use of bentonite grout for the sealing of the cracks in the channel floor is discussed in Section 3 of the Pines Tract FEIS (1999) and in more detail in the following section.

East Fork of Box Canyon Subsidence Monitoring and Mitigation

Portions of the East Fork of Box Canyon will be undermined and subsided as longwall panels 3LPE and 4LPE are extracted in 2003 through 2005. A monitoring plan that is more intensive than the general permit area has been proposed for monitoring vegetation, surface and ground water flows, and subsidence cracks and repair of the cracks in the portions of the East Fork to be undermined. The subsidence portion of the monitoring program is discussed in detail in the following text.

Prior to the initiation of undermining and subsidence, a presubsidence survey will be conducted in the East Fork of Box Canyon from the Joe's Mill Ponds downstream to a location above the west gate roads associated with the 3LPE panel. The survey will consist of video taping the condition of the stream channel paying particular note to surface flows and ground water discharge, vegetation types and conditions, animal life in the area including macroinvertabrates in the stream channel, soil conditions, and the general geomorphology of the area. A follow-up video survey will be made at the same time of year on the third year following undermining during September of 2008. A general comparison between the two tapes will be made to determine what, if any, effects to the parameters described above have occurred. The biological aspects of the video tape are discussed in greater detail in Section 3.2.2.2 while the monitoring of surface and ground water flows are discussed in Section 7.3.1.2.

The subsidence monitoring plan for the East Fork of Box Canyon will include frequent inspection of the stream channel during and after active subsidence. While mining is occurring under the mine where similar geomorphologic and geologic conditions occur. This program was developed and implemented by the Fall of 2000. Subsidence cracks in the area of the West Fork of Box Canyon were surveyed for their location. However, in the years 2000 through 2003 the width and/or offset of the cracks were not measured or the records were not kept. Width and/or offset measurements were made in the Fall of 2004 and will again be made in the Fall of 2005 and every year thereafter. It is believed by the permittee that any change in the width of the cracks can easily be tracked on an annual basis rather than a semi-annual basis. The permittee has observed that most subsidence cracks that develop in the mining area do not change significantly after the first 4 to 6 months following their creation. The crack measurement records will be reported in the mines annual report. Subsidence cracks in the area of the West Fork of Box Canyon are located in Longwall area 10 that has been mined out since 2001, and the area is now assumed to be dormant. 2008 will be the last year these cracks will be monitored since there will not be anymore movement in this area. stream channel and within the 15-degree angle-of-draw above the active longwall face, that area of the channel will be inspected twice a week for subsidence cracks or other related features. As the longwall face advances and the 15-degree angle-of-draw area follows, the portions of the channel that now lie outside the 15-degree angle-of-draw will be monitored for subsidence features on an every two week basis for eight weeks. Following the eight week period, the features will be monitored on a quarterly basis for two years following the cessation of subsidence related effects, if any, due to mining. Table 7-5A in Chapter 7 lists the schedule for water and subsidence monitoring frequency.

Mitigation of cracks that would appear to interrupt or divert flows from the stream channel will be sealed immediately with bentonite. Sufco will use hand placement methods when sealing cracks with bentonite. The individual(s) conducting the survey will be equipped with an adequate volume of bentonite, in powder, granular, and/or chip form, to seal small cracks. The bentonite may be placed by pouring it directly into the crack and hydrating with stream water or, if in an actively flowing portion of the stream, temporarily diverting the flow around successive portions of the crack using native soils and placing the bentonite in the exposed section of the crack until the crack is sealed. Sealing of the lower portions of the channel walls may also be required if the crack occurs where the channel is defined by bedrock. If cracks are present in channel walls defined by soil, the soil cracks will be hand filled using a native soil/bentonite mix. The sealing of the channel floor and walls will be accomplished with hand tools such as shovel, picks, trowels, etc. In the unlikely event that cracks too large to be sealed through the efforts of one or two persons in one day do occur and it appears there is a danger of water being diverted from the channel for an extended period of time, arrangements will be made to get additional help to the site as soon as possible.

Sufco will conduct longwall mining operations in such a manner as to minimize surface disturbance while mining within the 15-degree angle-of-draw area that includes the East Fork stream channel. This will be accomplished by advancing the longwall on a schedule where mining will not be suspended for a period to exceed 48 hours. This mining schedule has been discussed with the BLM. A similar mining schedule was successfully implemented at the Canyon Fuel Company Skyline Mine while the lower sections of Burnout Canyon were undermined. No damage to the stream channel or reduction in stream flows were noted as a result of undermining that portion of Burnout Canyon using the approved mining schedule.

A weekly report will be submitted via e-mail to the Division detailing the results of the inspections. The reports will include, but not necessarily be limited to: a map illustrating the current location of the longwall face; descriptions and dates of field activities; noted changes in stream and local geomorpholgy; location, width, frequency of cracks; and a description of repairs, if any, conducted. If the prescribed inspections cannot be conducted, the reason for the missed inspection and a record of the attempt to conduct the inspection will be submitted to the Division in the weekly report. The Division will be notified immediately after mining-induced cracks, if any, are found in the East Fork stream channel and the steps taken or planned to be taken as mitigation. Thereafter, the Division will be advised of continuing mitigation efforts, if needed, in the weekly report.

A copy of the October 2003 "Monitoring and Mitigation Plan for Mining Under the East Fork of Box Canyon" prepared by the Division and reviewed and accepted by the Forest with some modifications has been included in Appendix 3-10. The preceding paragraphs have been prepared based on this plan. Sufco will meet all of the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the East Fork of Box Canyon.

South Fork of Quitchupah 2R2S Block "A" and 3R2S Block "B" Subsidence Monitoring and Mitigation

Portions of the South Fork of Quitchupah will be undermined and subsided as longwall panels 2R2S and 3R2S are extracted. A monitoring and mitigation plan (Appendix 3-14) that is more intensive than the general Mining and Reclamation Plan area has been proposed for monitoring surface and ground water flows, subsidence cracks and repair of the cracks in the portions of the South Fork of Quitchupah channel to be undermined. The subsidence portion of the monitoring and mitigation plan is discussed in detail in the following text.

Prior to the initiation of undermining and subsidence, a pre-subsidence survey of the stream channel will be conducted in the portion of South Fork of Quitchupah that flows over the 2R2S and 3R2S panels and associated gate roads. The survey will consist of a gain/loss survey of flow within the stream channel paying particular attention to surface flows and ground water discharge, soil conditions, and the general channel geomorphology of the area. A similar study was performed in the past but all stream measurements were not conducted on the same date. The second gain/loss survey will be completed on a single day at or near base flow conditions late in the summer or early fall of 2011. The mine will attempt, as part of this second survey, to occupy the same monitoring sites in the panel area as those chosen in the initial survey. The monitoring of surface and ground water flows are discussed in greater detail in Section 7.3.1.2.

The subsidence monitoring plan for the South Fork of Quitchupah will include frequent inspection of the stream channel during and after active subsidence. While mining is occurring under the stream channel, and within the 15-degree angle-of-draw above the active longwall face, that area of the channel will be inspected semi-weekly for subsidence cracks or other related features. As the longwall face advances and the 15-degree angle-of-draw area follows, the portions of the channel that now lie outside the 15-degree angle-of-draw will be monitored for subsidence features on a quarterly basis for two years following the cessation of subsidence related effects, if any, due to mining.

Mitigation of cracks that interrupt or divert flows from the stream channel will be sealed immediately with an appropriate impermeable grout or, in some cases, native materials. Sufco will attempt to seal cracks with the least intrusive methods (typically hand placement of grout or native materials) first. The sealing material may be placed by pouring it directly into the crack or, if cracks occur in an actively flowing portion of the stream, the stream may be temporarily diverted using native materials (or a designed flume if necessary to maintain the flow) until the crack is sealed. If cracks are present in channel walls defined by soil, the soil cracks will be hand filled using a native soil/bentonite mix. The sealing of the channel floor and walls will be accomplished with hand tools such as shovel, picks, trowels, etc.

As a backup plan, in the unlikely event that cracks too large to be sealed through the efforts of one or two persons in one day do occur and it appears there is a danger of water being diverted from the channel for an extended period of time, the stream will be temporarily diverted using native materials and a pipe to carry the flow over the crack to maintain the channel flow . Arrangements will be made to get a contractor to the site as soon as possible to repair the crack after consultation with the Forest Service.

There may be sections of the stream channel that may require more intensive mitigation efforts to restore surface flows in the creek. These efforts could include the drilling of closely spaced shallow boreholes in and adjacent to the stream channel and the injection of an acceptable impermeable grout into the alluvium or bedrock. The work will be accomplished either using hand tools or low impact equipment to minimize surface disturbance. Existing roads and turnouts will be used as staging areas to locate larger equipment and supplies. Any hoses or lines will be transported from the staging areas to the nearby work sites either by hand, the use of pack animals, or by helicopter. This work will be done with a contractor selected after consultation with the Forest Service.

Additionally, it may be required to remove loose rock from the channel floor, either where the channel flows across thin-bedded bedrock or where large rock have fallen into the channel and is impeding flows. In the instance of the former, past experience has shown this can occur in the upper Blackhawk Formation and is easily repaired by removing enough of the broken channel surface to again expose the stream flow. In the instance of the later, removal of large rocks could be accomplished by drilling and then fracturing the rock into smaller fragments more easily moved to locations were they are not impeding flow. This work may be completed using available pneumatic or hydraulic tools that do not require road or pad building disturbances. In the unlikely event that large boulders do need to be moved, pumps and tanks necessary to complete the work will be located in pre-disturbed areas, such as roads or turnouts, and hoses will be walked into the work area.

A copy of the "Monitoring and Mitigation Plan for Undermining the South Fork of Quitchupah 2R2S Block "A" and 3R2S Block "B" has been included in Appendix 3-14. The preceding paragraphs have been prepared based on this plan. Sufco will attempt to meet all of the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the South Fork of Quitchupah 2R2S Block "A" and 3R2S Block "B". Refer to Chapter 3, Section 3.3.3.3 for additional information.

Sufco will conduct longwall mining operations in such a manner as to minimize surface disturbance while mining within the 15-degree angle-of-draw area that includes the South Fork stream channel. This will be accomplished by advancing the longwall on a schedule where mining will not be suspended for a period to exceed 48 hours.

A bi-weekly (once every two weeks) report on the impacts to stream flow and required mitigation, if any, will be submitted via e-mail to the Division and the forest detailing the results of the inspections while mining is occurring under the stream channel. The reports will include, but not necessarily be limited to: a map illustrating the current location of the longwall face; descriptions and dates of field activities; noted changes in stream and local geomorpholgy; location, width, frequency of cracks; and a description of repairs, if any, conducted. If the prescribed inspections cannot be conducted, the reason for the missed inspection and a record of the attempt to conduct the inspection will be submitted to the Division and the forest in the report. The Division and the forest will be notified immediately after mining-induced cracks, if any, are found in the South Fork stream channel and the steps taken or planned to be taken as mitigation. Thereafter, the Division and the forest will be advised of continuing mitigation efforts, if needed, in the report.

Though not anticipated, short segments of Cowboy Creek could be subsided in the SITLA Muddy Tract. If this is anticipated to occur, Sufco, will submit a plan for mitigation to address, if it occurs, adverse impacts to Cowboy Creek. With the approval of the Division and concurrence of the Forest, Sufco will instigate a flow monitoring plan similar to the plan implemented prior to the undermining of the East Fork of Box Canyon. If mitigation of surface cracks are required, methods similar to those proposed and implemented in the East Fork of Box Canyon as described above could be used.

Mining within the area of the East Fork of the Box Canyon, South Fork of Quitchupah and within the area of Cowboy Canyon in the SITLA Muddy Tract will be conducted in accordance with State and Federal rules and regulations and the requirements and stipulations presented in the BLM's Conditions of Approval of the Resource Recovery and Protection Plan (July 31, 2003) located in Appendix 1-2. A survey of the water quality and quantity of surface and groundwater, including State appropriated waters, within the SITLA Muddy Tract has been completed. The results of the area survey are included in the PHC for the SITLA Muddy Tract and included in Appendix 7-20. Ground and surface waters in the tract that have attached rights are listed in Appendix 7-1.

A discussion regarding the methods Sufco would employ to mitigate and replace an adversely affected State appropriated water supply is provided in Chapter 7, Section 7.3.1.8.

GREENS HOLLOW TRACT LEASE

Subsidence mining has the potential to be excluded from areas identified for protection such as stream segments where the overburden is insufficient in thickness or rock types to facilitate healing of surface tensile cracks. Along cliff escarpments where subsidence would impact cultural features or raptor habitat.

5.2.5.2 Subsidence Control

Adopted Control Measures. As indicated above, SUFCO Mine has adopted subsidence-control measures in areas where surface resources are to remain protected. These controls consist primarily of leaving support pillars in place in those areas designated on Plates 5-10A, 5-10B & 5-10C as not planned for subsidence. Based on experience and data collected from the lease area, the design of support pillars for those areas where subsidence is not planned has been based on the following equations:

$$SF = SD/OS \quad (5\text{-}1)$$

where SF = safety factor against pillar failure (fraction)

SD = support strength density (psi)
= $(Y_c)(1\text{-}ER)$

Y_c = average compressive yield strength of the coal (psi)
= 3090 psi for the Upper Hiawatha seam

ER = extraction ratio (fraction)
= $1\text{-}(A_p/A_t)$

A_p = pillar area (ft^2)

A_t = area supported by pillar (ft^2)

OS = overburden stress (psi)
= $(d)(D_o)/144$

d = overburden depth (ft)

D_o = overburden density (lb/ft^3)
= 160 lb/ft^3 for the lease area

Based on these equations and data, the support pillar designs summarized in Table 5-3 have been derived. This equation does not take into account either size effect or shape effects and is based on a one-dimensional stress field. Historically this equation has provided good results when used in areas where a number of uniform pillars are extracted. One area (5 North panels) of the mine experienced pillar failure when the area was flooded with water after mining of the panels had been completed. This particular area was mined using a double pass technique and the mining height was from 14 to 18 feet. The resulting pillars varied from 25 feet x 25 feet to 40 feet x 40 feet. The underlying floor was a weak mudstone that lost its cohesive strength when wet. When the 1R5N and 2R5N panels were flooded the underlying mudstone became saturated and lost its cohesive strength. This allowed the pillars in the area with SF < 2.5 to fail, because frictional confinement on the bottom of the pillar was lost. To prevent reoccurrence the Applicant will commit to not flood areas of the mine that have small pillars and a weak mudstone floor in areas where subsidence is to be prevented.

Compliance With Control Plan. SUFCO Mine will comply with all provisions of the approved subsidence control plan.

Correction of Material Damage. SUFCO Mine will try to plan mining operations so that no material damage occurs as a result of subsidence in the lease area. However, should material damage occur, SUFCO Mine will correct any material damage resulting from subsidence caused to surface lands to the extent technologically and economically feasible by restoring the land to a condition capable

TABLE 5-3

Minimum Support Pillar Requirements

Maximum Cover (feet)	Max. Allowable Ext. Ratio (percent)	Nominal Pillar Centers (feet)	Safety Factor
100	67	45 X 45	9.29
200	67	45 X 45	4.65
300	67	45 X 45	3.10
400	62	50 X 50	2.68
500	62	50 X 50	2.14
600	57	55 X 55	1.99
700	53	60 X 60	1.86
800+	50	65 X 65	1.74

of maintaining the value and reasonably foreseeable uses which it was capable of supporting before the subsidence. In addition, SUFCO Mine will either correct material surface damage resulting from subsidence caused to any structure or facilities by repairing the damage or compensate the owner of such structures or facilities in the full amount of the diminution in value resulting from the subsidence.

Protection of Significant Surface Resources. None of the following exist within the area of potential subsidence associated with the SUFCO Mine:

- o Public buildings or facilities,
- o Churches, schools, and hospitals,
- o Impoundments with a storage capacity of 20 acre-feet or more or bodies of water with a volume of 20 acre-feet or more,
- o Aquifers or bodies of water that serve as a significant water source for any public water supply system, or
- o Urbanized areas, cities, towns, or communities.

Hence, no special control measures are required to preclude subsidence impacts to these resources.

5.2.5.3 Public Notice of Proposed Mining

Should new lease areas be added to the SUFCO Mine, a public notice of proposed mining will be mailed to all owners and occupants of the affected surface property and structures above the proposed 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 SUFCO Mine's subsidence control plan may be examined.

5.2.6 Mine Facilities

5.2.6.1 Mine Structures and Facilities

Most surface structures and facilities at the SUFCO Mine have been in place for at least 10 years. Locations of these facilities are noted on Plate 5-2A,B,&C. Locations of the Link Canyon Substation facility and the horizontal power boreholes are noted on Plate 5-2D.

Table 5-4 lists the existing structures at the mine surface and at the Link Canyon facility area, their approximate dates of construction, and their general construction materials. All structures are actively maintained and are in good functional condition. Because the structures were constructed specifically for use as mining facilities and have been actively used and maintained since construction, 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.

All structures and facilities will be removed following mining in accordance with the reclamation plan discussed in Section 5.40.

GREENS HOLLOW: There is the potential that a ventilation and escapeway shaft facility will be required in mining the Greens Hollow Tract. Permitting required for the potential shaft will follow the acquisition of the Greens Hollow Lease.

5.2.6.2 Utility Installation and Support Facilities

Utility Installations. All coal mining and reclamation operations will be conducted to minimize damage, destruction, or disruption of services provided by electric lines, telephone transmission stations, water lines, and sewer lines which pass over, under, or through the permit area. Areas where these utilities are located are within non-subsidence zones. No other utility installations exist in the permit area. All utility installations associated with the SUFCO Mine will be removed following mining in accordance with the reclamation plan discussed in Section 5.40.

Support Facilities. Support facilities at the SUFCO 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:

- o Prevents or controls erosion and siltation, water pollution, and damage to public or private property,

TABLE 5-4

Description of Existing Structures

Structure	Construction Date	Construction Materials
Ambulance Garage	Summer 2007	Pre-Engineered Steel
Belt Deicer Tank	Fall 1994	Steel
Bulk & Used Oil Storage	Fall 1977 / Fall 2004	Steel & Concrete
Cap Magazine	Summer 1982	Steel & Wood
Chlorinator Building	Summer 1979	Steel
Covered Storage	Summer 1979	Concrete Block
Diesel Tank	Fall 1996	Steel & Concrete
Drainage Culverts	Summer 1976	Steel
Electrical Building	Summer 1977	Concrete Block
Fan	Winter 1980	Structural Steel
Fans - Mine #1 West Lease	Fall 2012 & Spring 2014	Structural Steel
Fire Water Tank - 300,000	Spring 2002	Steel & Concrete
Fuel Dock	Summer 1976	Concrete
Guard House	Summer 1977	Wood
Load-Out Belt	Summer 1975	Structural Steel
Lower Stacker Coal Storage	Summer 1975	Structural Steel
Lump Coal Belt	Fall 2010	Structural Steel
Lump Coal Storage	Fall 1981, Fall 1982	Concrete
No. 1 Belt	Fall 1977	Structural Steel
Office Building	September 1973 / 1990 / 2006	Pre-Engineered Steel
Powder Magazine	Summer 1982	Steel and Wood
Pulley Racks	Summer 1991	Steel
Pump Houses	Summer 1967 and 1975	Wood Frame & Metal
Rock Dust Bin	Fall 1976, Summer 1982	Structural Steel

TABLE 5-4 (Continued)

Description of Existing Structures

Structure	Construction Date	Construction Materials
ROM Coal Storage	Winter 1988	Struct. Steel/Concrete
ROM MCC Building	Winter 1988	Concrete Block
Sampler Building	Fall 2003	Structural Steel
Sand & Salt Storage	Fall 2010	Concrete
Seal Portals	At Reclamation	Concrete
Sediment Trap	Summer 1979	Concrete
Septic Tanks	Summer 1976 / Summer 2006	Steel / Concrete
Shelves	Summer 1990	Steel
Shop Garage	Summer 1989	Pre-Engineered Steel
Shop Office	Summer 1977	Wood
Side Release Tank	Fall 1997	Steel
Steam Cleaner Building	Fall 1981	Concrete
Stoker Belt	Fall 1977	Structural Steel
Stoker Bin	Fall 1977	Structural Steel
Stoker Coal Storage	Fall 1982	Concrete
Stoker Oil Tanks	Fall 1977 / Fall 2004	Steel & Concrete
Storage Trailers	1975	Wood & Aluminum
Substation - Lower	Fall 1991 / Fall 2006 -2007	Steel /Concrete/ Binwall
Ticket Printers	Summer 1996	Steel
Tipple Building	Fall 1977 / Mod. Fall 2008	Struct. Steel & Concrete
Tipple MCC Building	Summer 2005	Concrete Block
Tipple Office Building	Fall 1977	Concrete Block

TABLE 5-4 (Continued)

Description of Existing Structures

Structure	Construction Date	Construction Materials
Transfer Building	Fall 1977	Structural Steel
Truck Loader Bin	Fall 2002	Structural Steel
Truck Scale	1975 / 1982 / 1996	Structural Steel
Warehouse and Shop	Summer 1976	Pre-Engineered Steel
Warehouse Annex	Spring 2014	Pre-Engineered Steel
Water Tanks - Lower	Summer 1975/Summer 2002	Steel & Plastic
Water Tank - Upper	Summer 1975	Steel
Link Canyon Facilities		
Link Canyon Portals	Spring 2003	Steel
Link Canyon Substation	Summer 2000	Steel Skid
Four East Facilities		
Fan Generator Building	Fall 2003	Pre-Engineered Steel
4 East Fan	Spring 1996	Structural Steel

- o To the extent possible, using the best technology currently available, minimizes damage to fish, wildlife, and related environmental values, and
- o Minimizes additional contributions of suspended solids to stream flow or runoff outside the permit area.

All support facilities will be removed following mining in accordance with the reclamation plan discussed in Section 5.40.

Water Pollution Control Facilities. Water pollution control facilities at the SUFCO Mine consist of the sedimentation ponds, the appurtenant structures associated with the sedimentation ponds, and the sewage disposal leach field. All water pollution control facilities will be removed following mining in accordance with the reclamation plan discussed in Section 5.40.

The sedimentation ponds and appurtenant structures have been constructed as discussed in Chapter 7 and are used and maintained as discussed in Section 5.3.3.7. Sanitary sewage is routed by gravity through a pipeline from the mine surface facility to the leach field at the location in Convulsion Canyon shown on Plate 5-2B. The sewage facilities were designed for a projected total employment of 300 to 330 persons. A special-use permit has been obtained from the U.S. Forest Service and an operational permit has been obtained from the Utah Department of Health for use of the leach field. Copies of these permits are provided in Appendix 5-6.

5.2.7 Transportation Facilities

5.2.7.1 Road Classification

The mine access road is a primary public road. The truck haul loop through the yard and across the scale is a primary haul road. The access road to the office building and the shop/warehouse complex is an ancillary road. The access roads to the Link Canyon Substation No. 1 and No. 2 and Link Canyon Portal are an ancillary road. All other roads in the vicinity of the mine are public roads, most of which pre-date the mine. These public roads are not used for transporting coal and are only infrequently used by mine personnel for access to the water system, the electrical substations (East Side USFS Public Stock Trail and Link Canyon Road), for the performance of subsidence surveys, or for the collection of environmental monitoring data. These public roads are, therefore, classified as primary roads because they will be retained for an approved postmining land use after mine reclamation.

5.2.7.2 Description of Transportation Facilities

No surface conveyors (other than those in the mine yard immediately adjacent to the portals) or rail systems have been or will be constructed, used, or maintained within the permit area.

Conveyor Specifications. The conveyors within the surface facility complex are used to transport and stockpile coal. These conveyor locations are shown on Plate 5-2A. The No.1 Belt, Loadout Belt, and ROM Belts are 54" covered rigid structure conveyor belts. The Stacker Conveyor and Stoker Belt are 42" covered rigid structure conveyor belts. The Reclaim Belts are 42" uncovered catenary conveyor belts. The lump coal conveyor is a 36" covered rigid structure conveyor belt.

Road Specifications. Cross sections and profiles of roads that are used or maintained by SUFCO Mine are provided on Plate 5-9 and 5-2D. Information regarding road drainage structures is presented in Chapter 7.

The mine access road is a county road that extends from Interstate Highway 70 to the mine (a distance of 9.95 miles). This road is classified as a collector road in the State collector system. It was upgraded from a dirt Forest Service road in 1977.

The Utah Department of Transportation (UDOT) coordinated the upgrade of the road under a contract between Coastal States Energy Company, Sevier County, and UDOT. Coastal States initially paid for the work and was later reimbursed by the state under provisions of the Resource Development Act of 1975.

The road has a 28-foot finished width. The reconstruction consisted of 17.5 inches of untreated base course followed by 2.5 inches of gravel sub-base. The first paving course was a 3-inch bituminous lift. This was followed by a 4.5-inch bituminous surface course. A seal coat with 0.75-inch chips provides the wear surface.

SUFCO Mine constructed an ancillary road in 1980 extending from the mine access road to the sedimentation pond. The purpose of this road was to permit access to the pond area during construction activities. The road was retained following pond construction to permit access during pond maintenance (sediment removal, etc.).

A cross section of the sedimentation-pond access road is provided on Plate 5-9. This dirt road has a width of 22 feet. The road slopes into the hillside, with a drainage ditch being present where the road meets the toe of the hill.

The truck loop road is a paved road about 20 feet in width. It is constructed across the yard area and has an adequate base to support the 4 to 12 inch of asphalt paving. The access road to the office and shop/warehouse complex is of varying width and has both asphalt and gravel sections. This road has berms along steep down slopes of adequate height to prevent vehicles from leaving the road and going down the slope. Drainage from both the truck loop road and the access road to the office and shop/warehouse complex is routed to the sediment trap and then to the sediment pond for treatment.

The East Side USFS Public Stock Trail is a U.S. Forest Service road that has been upgraded within the disturbed area boundary to allow occasional vehicular traffic to the substation and fire water tank above the office building. The upgrade portion of this road has water bars and riprap to minimize erosion. Chapter 7 discusses the design of these controls in detail.

The Link Canyon Substation No. 1 and No. 2 and Link Canyon Portal access roads are a graveled dirt road about 16 feet in width. The Link Canyon access roads have a ditch that runs next to the road to minimize erosion. A cross section of the Link Canyon Substation No. 1

access road is provided on Plate 5-2D, cross section of the Link Canyon Substation No. 2 access road is provided on Plate 5-2E and cross section of the Link Canyon Portal access road is provided on Plate 5-2F. Chapter 7 discusses the design of these controls in detail.

The remaining roads used by SUFCO Mine are public roads that are owned and maintained by the U.S. Forest Service. These roads are generally unimproved dirt roads and are used for access to mine utilities as well as access to the lease area surfaces for the collection of monitoring data (environmental and subsidence data).

Drainageway Alterations. No alterations or relocations of natural drainageways are anticipated within the permit area to accommodate the needs of transportation systems.

Road Maintenance. The mine access road contract charges Coastal States with maintenance expenses above those received by Sevier County from Class B road funds. These Class B road funds are discretionary and are used by the county for salaries, equipment, and road maintenance projects on all Class B roads in the county. SUFCO Mine has been primarily responsible for road maintenance.

The mine access road is maintained to provide a safe and efficient transportation unit. Periodic repairs (including surface asphalt repair, ditch grading and repair, etc.) are made to the road as needed to keep the road in good working condition. SUFCO Mine provides primary maintenance of the mine access road (including snow removal and repair) from the edge of the permit area to the junction of the frontage road adjacent to Interstate Highway 70. The county and the State have both assisted in snow removal.

In the event that a catastrophic event occurs that causes damage to the mine access road, SUFCO Mine will repair that portion of the road that is present within the permit area as soon as practical after the damage has occurred. Furthermore, SUFCO Mine will cooperate with the county to promote rapid repair of that portion of the mine access road outside of the permit area as soon as practical following catastrophic damage.

The sedimentation-pond access road is maintained by SUFCO Mine as necessary to permit access to the pond during sediment removal. The truck loop road and the access road to the office and shop/warehouse complex are maintained by SUFCO Mine as necessary to provide a safe, smooth surface for vehicular traffic. The East Side road, Link Canyon Substation No. 2 access road and Link

Canyon Portal access road are maintained as necessary within the disturbed area boundaries by SUFCO Mine to minimize erosion and allow occasional access to the substations. No sand or salt is applied within the disturbed area boundaries for snow and ice removal. The remaining roads in the lease area are maintained by the U.S. Forest Service. SUFCO Mine has committed to repair damage to these public roads if this damage results from mining activities (e.g., subsidence).

5.2.8 Handling and Disposal of Coal, Excess Spoil, and Coal Mine Waste

5.2.8.1 Coal Handling and Transportation

Coal is removed from the underground workings using the mining methods and conveyor system described in Section 5.2.3. A material flow diagram for the surface at the mine portal is provided in Figure 5-1.

Run-of-mine coal is brought out of the mine by conveyor belt to a transfer bin. From the transfer bin, the coal is fed either to a temporary storage silo or to the crushing and screening system. After crushing and screening, the coal is loaded onto trucks (either through the truck loadout tube or by front-end loader) and transported. Lump, stoker, and crushed coal circuits exist in the system.

5.2.8.2 Overburden

No overburden is removed, handled, stored, or transported within the permit area.

5.2.8.3 Spoil, Coal Processing Waste, Non-Coal Waste, and Mine Development Waste

Excess Spoil. No spoil is generated at the SUFCO Mine.

(Figure 5-1)

Coal Flow Diagram

Coal Processing Waste. SUFCO Mine does not process their coal beyond crushing and screening. Thus, no coal processing waste is generated in the permit area.

Non-Coal Mine Waste. Non-coal (non-waste rock) waste generated in the permit area is temporarily stored in a protected area near the guard house at the location shown on Plate 5-2A. Once a sufficient amount of this waste accumulates to justify removal (approximately every 2 weeks), the waste is loaded onto a truck with a front-end loader and hauled to the Sevier County Landfill (see Section 5.2.1.1).

No non-coal (non-waste rock) waste is permanently disposed of within the permit area. 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 Subtitle C of the Resource Conservation and Recovery Act and any implementing regulations.

Underground Development Waste. Complete descriptions of the construction, use, maintenance, and removal of the waste-rock disposal facility are provided in the M&RP Volume 3 of this M&RP. This facility has been designed to accept approximately 10,000 tons of waste material per year for a projected period of at least 20 years.

Minimization of Acid, Toxic, and Fire Hazards. Data presented in Volume 3 of this M&RP and in Chapter 6 indicate that no materials at the site are acid forming. These same documents indicates that the waste rock has the potential of being slightly toxic forming with respect to boron. Should an acid- or toxic-forming problem with the waste rock be identified during future sample collection, those materials so identified will be buried within 30 days after the material is exposed at the mine site.

The area used for temporary storage of debris generated at the mine is protected from the wind by walls on three sides. The access to the storage area is sloped inward to prevent water from running off the waste pile prior to removal. Because debris that is generated at the mine site is only temporarily stored at the mine prior to off-site disposal, there is no significant potential for this debris to spontaneously combust. Fire extinguishers are kept on mobile equipment in the mine yard to extinguish any fires should combustion of the waste materials occur. Waste materials that constitute a fire hazard (e.g.,grease, lubricants, paints, and flammable liquids) will be stored in such a manner as to minimize any fire hazard. Empty containers of such products will only be stored temporarily at the mine-site prior to proper off site disposal.

5.2.8.4 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.

5.2.9 Management of Mine Openings

Thirteen underground mine openings exist within the permit area. Locations of these portals are shown on Plates 5-2A,C,&F. Six of these openings are located at the mine surface facilities in East Spring Canyon and serve as primary pathways for ingress and egress of personnel and machinery, removal of coal from the mine, and mine ventilation. The are located as follows:

East Spring Canyon portals - 4 portals and 2 intakes

3 East portals - 2 intakes

Quitchupah portals - 2 intakes

4 East portals - 1 intake and 1 portal

Link Canyon Portal - 1 intake

These remaining (non-East Spring Canyon) openings are used for mine ventilation and emergency egress. Each of these supplementary intakes is protected from unauthorized entry by the installation of steel sets and a locked chain-link gate. The keys for the gates are kept approximately 25 feet from the gates inside the mine. This permits emergency exit from the mine but prevents entrance from the outside.

Each underground mine opening is protected from deterioration through the installation of steel portal lliner, steel sets and timbers. These protective measures are inspected weekly to ensure that they remain in good condition.

Any portals which become temporarily inactive in the permit area, but have a further projected useful service, will be protected through the installation of a lockable chain-link gate as described above to prevent unauthorized entry. Warning signs will be posted to identify the hazardous nature of the opening. These protection and warning devices will be periodically inspected and maintained in good operating condition during the period of temporary inactivity.

5.30 Operational Design Criteria and Plans

5.3.1 General

This application contains a general plan for each sedimentation pond within the permit area. No other water impoundments or coal processing waste banks, dams, or embankments exist in the permit area.

No minable coal exists beneath the sedimentation ponds. Thus, subsidence will not affect operation of the ponds.

5.3.2 Sediment Control

Sediment-control measures for the SUFCO Mine and Link Canyon facilities are described in detail in Section 7.3.2. The sedimentation structures at the portal facilities consist of a concrete sediment basin in the mine yard, a primary sedimentation pond at the bottom of the fill slope upon which the mine yard is constructed and an overflow pond 800 feet below the primary sedimentation pond. At the waste-rock disposal site, a sedimentation pond and a decant pond have been constructed. Runoff-control structures at the mine yard and the waste-rock disposal site have been designed to convey runoff in a non-erosive manner. **Sediment-control measures at the Link Canyon facilities consists of containment berms, gravel and silt fencing.**

In addition to the use of sedimentation ponds and properly designed runoff-control facilities, sediment yields in the permit area are minimized by:

- o Disturbing the smallest practicable area during the construction or modification of surface facilities and

- o Contemporaneously reclaiming areas suitable for such reclamation.

During construction of the new overflow pond sediment from the disturbed area will be controlled by the use of containment berms and silt fencing.

5.3.3 Impoundments

5.3.3.1 Slope Stability

The only impoundments that are constructed, used, or maintained by SUFCO Mine are the sedimentation ponds at the portal facilities and the waste-rock disposal site. A slope-stability analysis for the primary sedimentation pond is provided in Appendix 5-7. According to this analysis, the minimum safety factors for the primary pond embankment are 2.2 under static conditions and 1.4 under seismic conditions. A slope-stability analysis for the overflow pond is provided in Appendix 7-23. These safety factors exceed the minimum requirements of R645-301-533.100.

A slope-stability analysis for the waste-rock disposal site sedimentation pond is presented in Appendix 5-7. According to this analysis, the minimum safety factors for the waste-rock area pond embankment are 2.8 under static conditions and 1.5 under seismic conditions. These safety factors exceed the minimum requirements of R645-301-533.100.

5.3.3.2 Foundation Considerations

No conditions were encountered during construction of the sedimentation ponds that suggested that the foundations upon which the ponds were constructed would be unstable. The slope-stability analyses presented in Appendix 5-7 indicate that the pond foundations will be stable under operating conditions.

Prior to construction of each sedimentation pond, all vegetative matter and topsoil was removed from the foundation area. Stability of the ponds has been enhanced through the installation of cutoff trenches and antiseep collars. Detailed cross sections of the sedimentation ponds are presented on Plates 7-5, 7-5A and in Volume 3.

5.3.3.3 Slope Protection

The outslopes and inslopes of the sedimentation ponds were revegetated following construction to minimize surface erosion and protect the embankments against sudden drawdown.

The primary sediment pond has 2H:1V to 3H:1V inslopes (Plate 7-5). The overflow pond has 2H:1V to 3H:1V inslope (Plate 7-5A) The waste rock disposal site sedimentation pond has a 3H:1V inslope (Volume 3 of this M&RP). Surface erosion would be minimized by the flatness of the inslopes.

In the event of a storm, rapid drawdown in the primary sedimentation pond would be restricted to the vertical distance between the spillway and the peak water level, a distance of 0.20 ft (Plate 7-5). The maximum drawdown in the overflow pond during a storm event is 0.74 ft (Plate 7-5A). The maximum drawdown in the waste rock disposal site sedimentation pond during a storm event is 1.1 ft (Appendix II, Volume 3). Drawdown of this size is not significant and, given the flatness of the inslopes, is not of erosional concern.

During decant of the sedimentation ponds, flow is controlled and is unlikely to cause surface erosion.

5.3.3.4 Embankment Faces

Embankment inslopes and outslopes were revegetated following construction of the sedimentation ponds. Riprap was also placed on the upstream faces of the embankments near the discharge structures.

5.3.3.5 Highwalls

No highwalls are located below the water lines of the sedimentation ponds.

5.3.3.6 MSHA Criteria

No sedimentation ponds in the permit area meet the size criteria of 30 CFR 216(a).

5.3.3.7 Pond Operation and Maintenance Plans

Each sedimentation pond is designed in accordance with R645-301-740. Details of these designs are presented in Chapter 7 and in Volume 3.

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.

The decant devices for the three sedimentation ponds consist of an inverted section of 12-inch diameter iron pipe connected to iron pipe at the primary sediment pond, an inverted section of 24-inch CMP pipe connected to an 18-inch pipe at the overflow pond and an inverted section of 12-inch CMP connected to 12-inch CMP pipe at the Waste Rock Disposal Site. Outflow from the decant devices is controlled by locked gate valves. Keys to the locks are maintained at the mine office. Details of the design of these decant devices are provided in Chapter 7.

Inspections of the sedimentation ponds are conducted on a quarterly basis (see Section 5.1.4.3). Maintenance that is required to keep the ponds in good working condition is performed as soon as practical following discovery of a maintenance need.

Sediment is removed from the ponds when it accumulates to 60 percent of the design sediment storage volume. This removed sediment is disposed of in the waste-rock disposal area.

5.3.4 Roads

5.3.4.1 Location, Design, Construction, Reconstruction, Use, Maintenance, and Reclamation

Control of Damage to Public or Private Property. All roads used by SUFCO Mine were designed in accordance with applicable county, UDOT, and U.S. Forest Service standards. By designing according to these standards, damage to public or private property has been minimized.

Road Surfacing. The surface of the mine access road consists of asphalt with a rock-chip wear surface (see Section 5.2.7.2). All ancillary roads are unimproved dirt roads. No acid- or toxic-forming materials have been used in the road surfaces.

Appendix 5-11 contains design drawing and information pertaining to the paving of an area in the upper mine yard and the repair and re-paving of the area between the shop/warehouse and the ambulance garage/Dodge Shop/steam bay/dog house and repaving of an area behind the shop/warehouse building. The areas to be paved will also have three segments of concrete ditch with drop drains. The drop drain will direct surface runoff into existing culverts, which discharge water into the sediment pond for treatment.

A fourth drop drain located in the left hand corner of the site plan drawing (Appendix 5-11) will collect water and direct the water through a drain pipe, inserted through a concrete wall to the lower yard. In the second phase of the paving and drainage installation the drain pipe through the concrete wall will be connected to a pipeline and connected to an existing pipeline. The water will proceed per the permitted drainage plan, through the yard to the sediment pond.

The design of the Type 2 junction box has a single inlet/outlet, the design of the Type 3 junction has multiple inlets/outlets, the dimensions are the same for either box see the Site Drainage Detail Sheet drawing G-9 in Appendix 5-11 for the dimensions.

Sufco Parking Lot (Constructed 1950's) - A plan has been provided in Appendix 5-12 for the replacement of the asphalt in parking area adjacent to the mine office building. After removal and prior to replacing the asphalt, the area will be re-graded to slope to the center of the parking area where an installed concrete waterway will assist in directing precipitation/water into structures in the permitted drainage plan to the sediment pond.

If necessary a grade ring will be added to the existing manhole to bring the manhole cover up to the grade of the replaced asphalt.

Due to the limited knowledge of the material beneath the existing asphalt there is uncertainty to whether existing material or acquired untreated base course will be used. Existing native material will be used for the construction base when it's characteristics meet compaction standards, however when required untreated base course (0-8") will be used. Excess native material generated during the regrading of the parking lot area depending on it quality will be hauled to the waste rock site and either mixed with the waste or placed on the subsoil pile. The area to be re-paved ties into existing features on each end which will require the grade to be similar to the grade prior to the repaving and installation of the concrete waterway. The reclamation cut/fill calculations for this area should remain unchanged.

Slope Stability. The stability of the mine access road embankment has been evaluated where the road enters the permit area. Results of this evaluation are presented in Appendix 5-8. This analysis indicates that the access road embankment has a minimum safety factor of 1.7 under static conditions. This value exceeds the safety factor of 1.3 required by R645-301-534.130.

An evaluation of the stability of the sedimentation-pond access road embankment is presented in Appendix 5-8. This evaluation indicates that the minimum static safety factor of the sedimentation-pond road embankment is 1.7. This value also exceeds the safety factor of 1.3 required by R645-301-534.130.

All other roads in the lease area are owned and maintained by the U.S. Forest Service. No stability problems have been noted on these roads.

5.3.4.2 Environmental Protection and Safety

Safety and environmental protection were primary concerns during the design and reconstruction of the mine access road and construction of the sedimentation-pond access road. The grade, width, and surface materials used for the roads were selected to be appropriate for the planned duration and use of the roads.

5.3.4.3 Primary Roads

General. The only primary road (outside of the disturbed area boundary) used or maintained by SUFCO Mine is the mine access road. The extension of this primary road within the disturbed area boundary is know as the truck loop road. This road was designed and constructed in consultation with the U.S. Forest Service in a manner that provided protection to fish, wildlife, and related environmental values. The road is being maintained by SUFCO Mine to meet its design standards throughout the life of the mining and reclamation activities. Catastrophic events are repaired as soon as practical after the damage occurs.

The mine access road was designed and reconstructed and is used and maintained in a manner that prevents damage to public or private property. Only nonacid- and nontoxic-forming materials were used to surface the road. The road embankments have a minimum static safety factor in excess of 1.3. Any portion of the road within the permit area that is
not to be retained for use under an approved post-mining land use will be reclaimed immediately after it is no longer needed for mining and reclamation operations.

Road Alignment. The reconstructed mine access road was located generally along the alignment of the former dirt road. The former road location had been in existence for many years and had not experienced major stability problems. Thus, the road is located on the most stable available surface, giving consideration also to safety and environmental protection.

Road Surfacing. The mine access road is surfaced with asphalt with a rock-chip wear surface. This surface was designed to account for the anticipated volume of traffic as well as the weight and speed of vehicles using the road. No problems have been encountered with the road surface since its construction in 1977.

Road Maintenance. The mine access road is maintained by SUFCO Mine in cooperation with the county and UDOT. As required, SUFCO Mine repairs the road surface, blades the adjacent drainage ditches, fills potholes, and resurfaces the road. Where necessary, minor reconstruction of road segments will occur, together with revegetation of road cuts and fills and removal of brush.

Road Culverts. All culverts along the mine access road were installed and are maintained in accordance with manufacturers recommendations. Thus, these culverts have sustained the vertical soil pressure, the passive resistance of the foundation, and the weight of vehicles using the road. No evidence of structural problems has been observed with the culverts.

5.3.5 Spoil
No spoil is generated in the permit area.

5.3.6 Coal Mine Waste
A detailed description of disposal of coal mine waste resulting from mining activities at the SUFCO Mine is provided in Volume 3 of this M&RP. That document is summarized in this section.

5.3.6.1 Design
The waste-rock disposal facility was designed with a minimum static safety factor of 2.62. This design and the associated evaluations were based on the results of detailed foundation and laboratory analyses of soils at the site of the disposal facility.

5.3.6.2 Waste Emplacement
Waste rock is placed at the disposal site in a manner that enhances the stability of the waste pile. The waste is placed in horizontal lifts that do not exceed three feet in thickness. The material is dumped from the haul trucks. Dozers are used to rework and initially compact the dumped material. Additional compaction of each lift is accomplished by routing the loaded haul trucks over the lift surface in such a manner as to cover the entire area uniformly. The waste rock is covered periodically to minimize public hazards and the potential for spontaneous combustion.

5.3.6.3 Excess Spoil Fills
No excess spoil fills exist in the permit area.

5.3.6.4 Impounding Structures Constructed of Coal Mine Waste
No impounding structures have been constructed of coal mine waste in the permit area.

5.3.6.5 Disposal of Coal Mine Waste in Special Areas
No coal mine waste is disposed of in special areas in the permit area.

5.3.6.6 Underground Development Waste
A detailed description of the geotechnical investigations, design, construction, operation, maintenance, and reclamation of the waste-rock disposal site is provided in Volume 3. This M&RP also contains:

- o A description of pre-disturbance soil resources at the waste-rock disposal site,
- o A description of plans for stockpiling topsoil at the waste-rock disposal site, and
- o A discussion of the suitability of the material for reclamation.

5.3.6.7 Coal Processing Waste

No coal processing waste is generated within the permit area.

5.3.6.8 Coal Processing Waste Banks, Dams, and Embankments

No coal processing waste banks, dams, or embankments exist within the permit area.

5.3.6.9 Refuse Piles

A detailed description of the waste-rock disposal site is provided in Volume 3 of this M&RP. This M&RP volume contains:

- o A description of pre-disturbance soils at the site and the suitability of the waste rock for reclamation,
- o Certification of the design and plans,
- o Compliance with applicable MSHA regulations,
- o A description of proposed inspection activities,
- o A description of the design, stability, operation, and reclamation of the waste-rock site, and
- o A discussion of runoff- and sediment-control plans associated with the site.

5.3.7 Regraded Slopes

5.3.7.1 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 SUFCO Mine to meet regulatory requirements for:

- o Protection of fish, wildlife, and related environmental values (R645-301-358),
- o Certification of the design of the mine access road (R645-301-512.250),
- o Road classification (R645-301-527.100),
- o Maintenance of roads to meet their design standards throughout their use or remediation of damage caused by catastrophic events (R645-301-527.230),
- o Location, design, construction, reconstruction, use, maintenance, or reclamation of roads in a manner that prevents damage to public or private property, utilizes nonacid- and nontoxic-forming substances in road surfacing, and achieves an acceptable static safety factor against slope failure (R645-301-534.100),
- o Design of roads to ensure environmental protection and safety (R645-301-534.200),
- o Design, location, surfacing, maintenance, and drainage of primary roads in a manner that allows continued use of the road (R645-301-534.300),
- o Retention of a road following reclamation that is not necessary as part of an approved post-mining land use (R645-301-542.600 and R645-301-762), and
- o Road drainage (R645-301-742.410, R645-301-742.420, and R645-301-752.200).

5.3.7.2 Regrading of Settled and Revegetated Fills

SUFCO Mine is requesting a variance from the approximate original contour requirements of R645-301-553.600. This request is presented in Appendix 5-2. The variance request is not based on the presence of settled and revegetated fills.

5.40 Reclamation Plan

5.4.1 General

5.4.1.1 Commitment

Upon the permanent cessation of coal mining and reclamation operations at the SUFCO Mine, SUFCO Mine will close, backfill, or otherwise permanently reclaim all affected areas in accordance with the R645 regulations and this reclamation plan.

5.4.1.2 Surface Coal Mining and Reclamation Activities

No surface coal mining and reclamation activities are conducted in the permit area.

5.4.1.3 Underground Coal Mining and Reclamation Activities

All surface equipment, structures, or other facilities not required for continued underground mining activities and monitoring, unless approved by the UDOGM as suitable for the post-mining land use or environmental monitoring, will be removed and the affected lands reclaimed.

5.4.1.4 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.

5.4.2 Narratives, Maps, and Plans

5.4.2.1 Reclamation Timetable

A timetable for the completion of each major step in the reclamation plan is presented in Figure 5-2.

5.4.2.2 Plan for Backfilling, Soil Stabilization, Compacting, and Grading

The regrading plan for the waste rock disposal facility is presented in Volume 3. Regrading at the waste rock facility will occur on a continuing basis as the rock is emplaced.

(Figure 5-2)

Reclamation Timetable

The regrading plan for all mine openings is presented in Section 5.4.2.7 of this M&RP.

The regrading plan for the 4E Fan facility area will be to reclaim it for its entire length. The pre-existing slopes for the 4E Fan facility area will be restored to the extent possible and in accordance with Approximate Original Contour regulations using all the fill material stored in the pad area. The slopes will be constructed using equipment small enough to be transported through the mine such as backhoes and dozers to move the soil. The surface of the replaced soil will be prepared for reseeding as specified in Section 2.4.2 of this M&RP. Soil compaction will be avoided as much as possible through limiting the number of equipment passes over a given area. The area will be reseeded in accordance with the methods described in Section 3.40 of the permit. Since the reclaimed acreage will be the same as the pad disturbed area, erosion controls for final reclamation will be placed in essentially the same location as shown on Plate 5-2C. The reclamation soil surface and vegetation will be monitored and maintained in accordance with this M&RP.

The regrading plan for the Link Canyon Portal and Link Canyon Substation No. 1 and No. 2 facility areas will be to reclaim them for there entire length. The pre-existing slopes for the Link Canyon Portal and Link Canyon Substation No. 1 and No. 2 facility areas will be restored to the extent possible and in accordance with Approximate Original Contour regulations using all the fill material stored in the three respective pad areas. The power cable and communication boreholes at Link Canyon Substation No. 2 will be capped, sealed, and plugged with concrete as described in section 7.6.5 of this M&RP. The marker flagging as described in Section 2.3.1.1 separating the original, undisturbed topsoil surface beneath the stockpiled topsoil will need to be located and used as a guide when removing the side cast materials stored on the outslope. The slopes will be constructed using equipment such as trackhoes and dozers to move the soil. Topsoil from the Link Canyon Portal topsoil storage pile, the Link Canyon Substation No. 1 outslope topsoil storage area and the Link Canyon Substation No. 2 topsoil storage pile will be redistributed over the newly restored slope as indicated in Section 2.4.2. The surface of the replaced soil and the original, undisturbed topsoil surface beneath the stockpiled topsoil will be prepared for reseeding as specified in Section 2.4.2 of this M&RP. Soil compaction will be avoided as much as possible through limiting the number of equipment passes over a given area. The area will be reseeded in accordance with the methods described in Section 3.40 of the permit. Since the reclaimed acreage will be the same as the pad disturbed area, erosion controls for final reclamation will be placed in essentially the same location as shown on Plates 5-2D, 5-2E, and 5-2F. The reclaimed pads, access roads, and affected slopes will be fenced with a three-strand barbwire fence to prevent damage from cattle grazing during reclamation. The reclamation soil surface and vegetation will be monitored and maintained in accordance with this M&RP.

The regrading plan for the East Spring Canyon facility is summarized below. Engineering calculations and design details associated with this regrading plan are presented in Appendix 2-4. The East Spring Canyon regrading plan was designed to meet the objectives of balancing cut and fill quantities, maintaining a geotechnically stable surface configuration, and controlling erosion. Major features of the East Spring Canyon regrading plan are:

- o Reduction of the slope at the southern end of the mine-yard fill,
- o Removal of the sedimentation pond dams and implementation of interim sediment-control measures,
- o Backfilling to remove highwalls and cut slopes to the extent possible within the objectives noted above (cut and fill balance, site stability, and erosion control),
- o Construction of an armored embankment at the inlet of the main reclamation channel, and
- o Construction of reclamation diversion channels.

The estimated cut quantity for East Spring Canyon is approximately 74,734 cubic yards with an estimated fill of 71,173 cubic yards (see Appendix 2-4). The difference between these two quantities is anticipated to be balanced by compaction. Regrading activities will continue until the final surface configuration defined by Plates 5-3A&B and 5-4 has been achieved. Details regarding topsoil placement and revegetation following regrading are provided in Chapters 2 and 3, respectively.

The Warehouse Annex building will be constructed in an area which has existing drainage controls and the soil have been pre-disturbed (Plate 5-2A & 5-2B). The area will be leveled to allow access to the building by small equipment and delivery trucks.

A soil nail wall will be constructed to stabilize the slope directly behind the Annex building. The technique uses grouted tension-resisting steel elements drilled into an exposed soil face and grouted into place. Design details and drawings associated with the soil nail wall (shotcrete) and soil nails is located in Appendix 5-11. Sheet 1.2 illustrates the location of the wall and soil nails. As noted on Sheet 1.2 the exact length of the wall will need to be field-fit, thus on the illustration the location of soil nails extends beyond the end of the wall. Sheet No. 1.4 illustrates the soil material to be removed to facilitate the instillation of the wall and facilitate the insertion of the soil nails.

The soil nails will remain in the slope and covered with soil during reclamation, the shotcrete wall will be broken up and buried during reclamation. Bonding for the removal of the shotcrete wall has be provided in Appendix 5-9. The reclamation contours of the slope are shown on Plate 5-3B.

Building and Utility Demolition. Prior to significant regrading activities at the East Spring Canyon facility, existing buildings, walls, utilities, coal-handling facilities, and other above-ground structures will be removed from the area. To the extent possible, these structures and facilities will be salvaged. Those materials requiring off-site disposal will be placed in a licensed landfill. Final decisions regarding salvage or disposal of structures and equipment will be made just prior to reclamation following an assessment of the salvageability of the structures and equipment. If foundations and buried utilities will not interfere with regrading activities, they will be left in place for on-site burial. The water and sewer lines were installed and buried prior to Aug. 3, 1977 under a Special Use Permit with the Forest Service and will be left in place upon completion of mining activities.

Southern Slope Regrading. The present slope at the southern end of the mine yard will be cut from its existing continuous slope of approximately 1.4H:1V to a slope of 2.5H:1V in the center of the slope. The regraded slope will taper along the east and west sides of the slope to blend with the natural slopes. The recontoured slope will have 10-foot wide benches on 80-foot vertical centers to collect slope runoff and minimize the potential for erosion.

Proposed post-reclamation contours of the East Spring Canyon site are presented in Plate 5-3A&B. Analyses presented in Appendix 2-4 indicate that the fill under this configuration will have a minimum static safety factor against failure of 1.51.

Backhoes, loaders, dozers, and other appropriate earthmoving equipment will be used to regrade the southern slope. Material removed from the southern slope will be backfilled as described below to reduce cut slopes in the mine yard and achieve the final surface configuration presented on Plate 5-3A&B.

Primary Sedimentation Pond, Overflow Pond and Dam Removal and Interim Sediment Control. The existing primary sedimentation pond at the base of the mine-yard fill slope will be removed to allow construction of the main reclamation stream channel. All of the fill material from the pond and the dam west of the reclamation channel will be removed. This material will be used as fill in the mine-yard area as needed to reduce final slope grades. The pond and dam fill material east of the reclamation channel will be cut back to a 2H:1V slope above the rock channel. The regrading plan for the overflow pond will be to reclaim the area for its entire length. The pre-existing slopes and channel for the overflow pond area will be restored to the extent possible and in accordance with Approximate Original Contour regulations using all the fill material stored in the dam. Topsoil from the overflow pond topsoil storage pile will be redistributed over the newly restored slopes. Removal of the primary sedimentation pond, overflow pond and dam will be accomplished using backhoes, loaders, dozers, and other appropriate earthmoving equipment.

Immediately following removal of the sedimentation pond and dam, silt fences will be installed for interim sediment control at the locations noted on Plate 5-3A&B to control erosion prior to revegetation success. Immediately following removal of the overflow pond and dam, silt fences will be installed for interim sediment control at locations below the area to control erosion prior to revegetation success. These silt fences will be installed as noted in Figure 5-3. In addition to silt fences, straw-bale dikes may be installed on a temporary basis as necessary to control localized erosion prior to the establishment of revegetation efforts. If installed, locations of the straw-bale dikes will be selected to reduce sediment contributions to runoff based on field observations. Straw-bale dikes will be installed as noted in Figure 5-3.

Backfilling and Compaction. All vegetation, organic matter, and debris will be cleared from areas to receive fill. The cut material from site regrading, sedimentation pond removal, and channel excavation will be placed as fill and graded to facilitate drainage from the mine site and contributing side areas. All fill placed during recontouring of the site will be compacted to at least 85 percent of maximum Proctor density (ASTM D698). Compaction will be accomplished using repeated passes of rubber-tired equipment, rollers, and other appropriate equipment.

Side hill embankments, where the width (including bench cuts) is too narrow to allow access

(Figure 5-3)

Straw-Bale Dike & Silt Fence Installation Procedures by compaction equipment, will be initially constructed by end dumping, but only to a width necessary to allow compaction equipment access. After this is achieved, the fill will be placed in lifts and compacted to at least 85 percent of maximum Proctor density. Lifts will be placed with a thickness when compacted of no more than 8 inches. Care will be taken to ensure that fill materials are not frozen during placement or compaction. Any areas that are damaged by freezing will be reconditioned, reshaped, and recompacted to at least 85 percent of maximum Proctor density. All fill placement and compaction activities will be overseen by an experienced engineer.

Construction of Main Channel Inlet. The main reclamation channel to be constructed at the site will convey water from East Spring Canyon and Mud Spring Hollow above the mine to East Spring Canyon below the mine. The proposed location of this channel is shown on Plate 5-3A&B. Details regarding channel design are provided in Appendix 2-4.

Deposition of naturally-occurring sediment will occur where East Spring Canyon and Mud Spring Hollow enter the main reclamation channel due to abrupt changes in channel gradient (12 to 17 percent in the natural channels and 2 to 10 percent in the reclamation channel). Therefore, the inlet section for the reclamation channel was designed to provide for sediment accumulation. This inlet will also direct flows from the two undisturbed canyons to the reclamation channel.

The sedimentation area of the inlet section will be constructed by excavating all fill from the section down to undisturbed native materials. The minimum depth of excavation will be 7 feet even if this excavation must occur in bedrock. The excavated bank of the inlet section will be reinforced with riprap where this bank occurs on fill. No reinforcing will be used where the excavated bank occurs in bedrock. The reinforced bank will be keyed into bedrock to prevent underflow via piping. Bank reinforcing will consist of riprap underlain by filter fabric as detailed in Appendix 2-4.

During excavation of the inlet section, the existing bypass culverts for East Spring Canyon and Mud Spring Hollow will be removed.

Construction of Reclamation Channels. Reclamation channels will be constructed at the locations shown on Plate 5-3A&B. The main reclamation channel will be constructed along the east side of the existing fill into bedrock. East and west collector channels will be constructed to capture runoff from undisturbed areas and convey this runoff to the main channel. Intercept channels will also be placed on the southern slope following regrading to minimize erosion of the slope. Details regarding the design and construction of these channels are provided in Appendix 2-4. A summary of the reclamation channel design parameters is presented in Table 5-5.

The main reclamation channel downstream from the inlet will consist of trapezoidal sections cut into bedrock. Bottom widths on these sections will range from 10 to 17.5 feet, with side slopes varying from 1H:1V to 0.75H:1V. The narrower width and steeper side slope will occur where the bottom gradient of the channel is steepest.

All existing fill will be removed from the alignment of the main reclamation channel to ensure that the channel bottoms in bedrock. During this excavation, sections of the channel may be cut deeper than is desirable to maintain the necessary gradient (see Table 5-5). In such areas, coarse rock from the channel excavation will be used to fill undesirable depressions. This rock fill will then be covered with 12 inches of grout meeting the specifications described in Section 5.4.8 of Appendix 2-4.

The main reclamation channel will discharge into the existing stilling basin downstream from the sedimentation pond. No modification of the existing stream channel will occur downstream from the stilling basin.

The west collector channel will be excavated primarily into bedrock at the western edge of the existing mine site. This channel will collect runoff from undisturbed areas west of the site and convey this runoff across the site to the stilling basin downstream from the existing

TABLE 5-5

Reclamation Channel Design Summary

Reach	Bottom Slope (ft/ft)	Side Slope (H:V)	Bottom Width (ft)	Bank Height (ft)	Design Velocity (ft/s)	Design Flow Depth (ft)
Main Channel						
1	Varies	Varies	Varies	7.0	Varies	Varies
2	0.100	1:1	17.5	6.0	22.67	2.73
3	0.065	1:1	17.5	6.0	19.59	3.10
4	0.020	1:1	17.5	7.5	13.06	4.38
5	0.571	0.75:1	10.0	5.5	46.14	2.31
6	0.546	0.75:1	10.0	5.5	45.41	2.34
7	0.356	1:1	17.5	5.5	34.58	1.87
8	0.151	1:1	17.5	5.5	26.01	2.41
West Collector Channel						
A-1	0.020	1:1	2.0	2.0	3.27	0.59
A-2	0.020	1:1	2.0	2.0	4.07	0.85
A-3	0.018	1:1	3.0	3.0	4.62	1.07
A-4	0.015	1:1	3.0	3.0	4.61	1.27
A-5	0.501	1:1	2.0	3.0	16.39	0.52
East Collector Channel						
B-1	0.010	1:1	2.0	2.0	2.60	0.71
B-2	0.060	1:1	2.0	2.0	4.87	0.42
B-3	0.270	1:1	3.0	3.0	10.67	0.41
B-4	0.125	1:1	2.0	2.0	6.23	0.34
B-5	0.526	1:1	2.0	3.0	12.69	0.34

sedimentation pond. The channel will consist of trapezoidal sections with bottom widths and depths of 2 to 3 feet. The downstream portion of this channel will be constructed in bedrock where it flows down the slope to the main reclamation channel.

The northern portion of the west collector channel will cross fill. At this location, a triangular channel will be constructed, consisting of riprap underlain by filter fabric. Riprap specifications and other details regarding the design and construction of the west collector channel are provided in Appendix 2-4.

A tributary of the west collector channel will be constructed along the top of the regraded southern slope. This tributary will preclude runoff from flowing down the slope, thereby also precluding excessive erosion of the slope. The tributary will be triangular in shape and constructed of riprap overlying filter fabric as noted in Appendix 2-4.

The east collector channel will be cut into bedrock at the head of the existing cut slope along the east side of the mine site. This channel will have two outlets, conveying runoff from undisturbed areas to the main reclamation channel and to the stilling basin downstream from the sedimentation pond. The channel will consist of trapezoidal sections with bottom widths and depths of 2 to 3 feet. Details regarding the design and construction of the east collector channel are provided in Appendix 2-4. The downstream portion of this channel will be constructed in bedrock where it flows down the slope to the main reclamation channel.

Two intercept channels will be constructed on the regraded southern slope. The purpose of these channels will be to reduce the effective slope length, thus minimizing the potential for erosion of the slope. The channels will be constructed on benches that are placed to divide the slope into thirds (see Plate 5-3A&B). The intercept channels will be triangular and lined with riprap and filter fabric. They will discharge to the main reclamation channel. Details regarding the design and construction of the intercept channels are provided in Appendix 2-4.

5.4.2.3 Final Surface Configuration Maps and Cross Sections

Final surface configuration maps and cross sections for the East Spring Canyon site are provided on Plates 5-3A&B and 5-4, respectively. The primary access road to the mine yard will be removed at the permit boundary. Existing public access roads within the lease area will remain following reclamation. No facilities related to the coal mining operations will remain in the permit area following reclamation. Information regarding the final surface configuration of the waste-rock disposal site is provided in Volume 3. Final surface configuration maps and cross sections for the 4E Fan facility, Link Canyon Substation facility and all out-by mine portals are provided on Plates 5-2C, 5-2D, 5-2E and 5-2F, respectively.

5.4.2.4 Removal of Temporary Structures

All surface structures associated with the mining operation will be removed as outlined in Section 5.4.2.2. A description ensuring that all structures and sedimentation ponds have been removed will be provided to the UDOGM before seeking bond release or abandoning the permit area.

5.4.2.5 Removal of Sedimentation Ponds

Information regarding removal of primary sedimentation ponds and overflow pond associated with the SUFCO Mine is provided in Section 5.4.2.2 for the East Spring Canyon facility and in Volume 3 of this M&RP for the waste rock disposal site. The timetable for removal of the minesite ponds is indicted in Figure 5-2.

5.4.2.6 Roads

The primary mine access road will be reclaimed beginning at the guard shack at the entry to the mine yard. This road will be regraded by removing any remaining asphalt, removing fill from beneath the road to the natural ground surface, and placing the fill against the adjacent cut slope. Placement and compaction of the backfill material will be as indicated in Section 5.2.4.2.

Proposed reclamation contours following closure of the mine access road are presented in Plate 5-3A&B. The roadside culvert referred to as Pipe No. 5 (see Chapter 7) that exists immediately south of the guard shack will be retained for runoff control along the unreclaimed portion of the road.

Recontouring of the road surface near the guard shack will result in closure of the road to traffic. In addition, "Dead End" signs that meet UDOT specifications will be placed in the center of the access road where regrading begins and on the access road in Sec. 11, T. 22 S., R. 4 E., where the Convulsion Canyon road departs from the access road to the mine.

The sedimentation pond access road will be reclaimed for its entire length. This road will be regraded by removing fill from beneath the road to the natural ground surface and placing the fill against the adjacent cut slope. Placement and compaction of the backfill material will be as indicated in Section 5.2.4.2. Proposed reclamation contours following closure of the sedimentation pond access road are presented in Plate 5-3A&B. This road will be closed to traffic following reclamation by virtue of its non-existence.

The Link Canyon Portal and Link Canyon Substation No. 1 and No. 2 access roads will be reclaimed for there entire length the same way as the Link Canyon Portal and Link Canyon Substation No. 1 and No. 2 facility areas as described in Section 5.4.2.2 of this M&RP. Original contours of the Link Canyon Portal access road are presented on Plate 5-2F. Original contours of the Link Canyon Substation No. 1 and No. 2 access roads are presented on Plates 5-2D and 5-2E. These roads will be closed to traffic following reclamation by virtue of there non-existence.

Following regrading of the roads, topsoil will be applied to the regraded surfaces and the area will be revegetated. Topsoiling and revegetation activities are discussed in Chapters 2 and 3, respectively.

5.4.2.7 Final Abandonment of Mine Openings and Disposal Areas

Abandonment of Openings. All mine openings will be sealed at least 25 feet inside the mine opening. Prior to installation of the seal, all loose material will be removed from the roof, floor, and rib of the mine within three feet of the seal area. The seal will then be constructed using solid concrete blocks (average minimum compressive strength of 1,800 psi) with nominal dimensions of 6 inches high, 8 inches wide, and 16 inches long. Mortar will consist of one part cement, three parts sand, and no more than seven gallons of water per sack of cement.

The seal will be recessed at least 16 inches deep into each rib and 12 inches deep into the floor. No recess will be made into the roof. In the bottom course, each block will be laid with its long axis parallel to the rib. The long axis in succeedingly higher courses will be perpendicular to the long axis of the blocks in the preceding course. An interlaced pilaster will be constructed in the center.

The seals will have a thickness of approximately 16 inches. Following seal construction, the entries will be backfilled from the seal to the outside surface with soil that is sloped at the surface to match the final slope at the entry. Due to the location of some entries that do not have surface access, such as the 4E Fan facility, the entries will be backfilled from inside the mine before the seal construction. Due to safety reasons, some entries that are completely cribbed off due to bad roof conditions, such as the 3E Portals and Quitchupah Portals, will need to be backfilled with the use of explosives to blast the cribs and roof rock down to fill the entry before the seal construction. The surface soil will then be raked and revegetated with the approved seed mixture.

Alternatively, a cast in place MSHA approved seal will be installed with a minimum thickness of 3 feet and with a minimum compressive strength of 200 psi.

Disposal of Excess Spoil. No excess spoil is generated in the permit area.

Disposal of Coal Mine Waste. All coal mine waste generated at the SUFCO Mine is disposed of at the waste-rock disposal site. Information regarding disposal practices and reclamation plans for this facility is provided in Volume 3.

Disposal of Non-Coal Mine Wastes. All non-coal (non-waste rock) waste generated from mining and reclamation operations is disposed of as outlined in Sections 5.2.1.1 and 5.2.8.3. Following cessation of mining activities, non-coal mine waste that is still temporarily stored at the site will be removed and disposed of in the Sevier County Landfill. Non-coal waste that is generated during the course of reclamation (i.e., as a result of building demolition) will likewise be disposed of at an off-site location (either the Sevier County Landfill or an alternative state-approved solid-waste disposal area).

5.4.2.8 Estimated Cost of Reclamation

The estimated cost to reclaim the SUFCO Mine surface facilities is provided in Appendix 5-9. The paving project for the upper mine yard has been included in the reclamation bond.

5.50 Reclamation Design Criteria and Plans

5.5.1 Casing and Sealing of Underground Openings

Each underground opening to the mine will be sealed and backfilled when no longer needed for monitoring or other use approved by the UDOGM upon a finding of no adverse environmental or health and safety effects. Permanent closure measures will be as described in Section 5.4.2.7. This closure method has been designed to prevent access to the mine workings by people, livestock, fish and wildlife, and machinery. The closures have also been designed to keep water from flowing from the mine workings to prevent acid or other toxic drainage from entering ground and surface waters.

5.5.2 Permanent Features

5.5.2.1 Small Depressions

During final grading and spreading of topsoil, small depressions will be left in the soil. The purpose of these depressions will be to retain moisture, minimize erosion, and assist revegetation.

5.5.2.2 Permanent Impoundments

No permanent impoundments will be left following reclamation.

5.5.3 Backfilling and Grading

Plans for backfilling and grading of the site upon reclamation have been presented in Section 5.4.2.2. This plan was designed to comply with the applicable requirements of R645-301-500 and R645-301-700. As indicated in Section 5.4.2.2, backfilling and grading operations will be conducted in a controlled manner.

5.5.3.1 Disturbed Area Backfilling and Grading

Approximate Original Contour. . The pre-SMCRA cut slopes are shown as part of the pre-1977 disturbance on Plate 5-2B. The cut slopes to be retained are shown on Plate 1 of Appendix 5-2 as A-A', B-B', C-C' and D-D'. A study of the existing cliffs in the area (Appendix 5-2) shows that these cut slopes will approximate original contour.

Elimination of Highwalls, Spoil Piles, and Depressions. The backfilling and grading plan has been designed to eliminate highwalls at the site. No spoil piles exist. With the exception of the small depressions discussed in Section 5.5.2.1, the only depressions that will remain at the site following reclamation will be the inlet section of the main reclamation channel (which was designed as a sedimentation structure to prevent clogging and subsequent overtopping of the channel - see Section 5.4.2.2) and the stilling basin at the downstream end of the main reclamation channel (which is being retained to reduce the velocity of flows exiting the channel - see Section 5.4.2.2).

Slope Stability. Backfilled and regraded slopes have been designed to not exceed the angle of repose. Final reclamation slopes have been designed with a minimum static safety factor of 1.51 (see Section 5.4.2.2), thus preventing slides.

Erosion and Water Pollution. Temporary sediment-control measures will be implemented following backfilling and regrading as outlined in Section 5.4.2.2. As vegetation becomes established on the reclaimed surfaces, erosion potentials will be further minimized. By minimizing erosion, water pollution will also be precluded. Additional water-quality concerns do not exist at the site (see Chapter 7).

Post-Mining Land Use. The disturbed area will be backfilled and regraded in a manner that supports the approved post-mining land use.

5.5.3.2 Spoil and Waste

Spoil. No spoil is generated within the permit area.

Refuse Piles. Details regarding the design, operation, final surface configuration, and final grading of the waste-rock disposal site is provided in Volume 3. As noted in this M&RP, the waste-rock disposal site has been designed to achieve a long-term static safety factor of 2.62 which is more than twice the minimum acceptable static safety factor of 1.3 as required by R645-301-553.260.

Coal Processing Waste. No coal processing waste is generated within the permit area.

5.5.3.3 Exposed Coal Seams, Acid- and Toxic-Forming Materials, and Combustible Materials

Exposed Coal Seams. Coal seams that were exposed during mining will be covered with a minimum of four feet of nontoxic and noncombustible materials during final backfilling and grading. This cover material may consist of material removed during grading of the site (see Section 5.4.2.2), subsoil, and/or topsoil.

Acid- and Toxic-Forming Materials. No acid-forming materials exist at the site (see Section 5.2.8.3). Potentially toxic-forming materials are disposed of at the waste-rock disposal site in accordance with Volume 3 of this M&RP.

Combustible Materials. All combustible materials that are exposed, used, or produced during mining will be disposed of off site as outlined in Section 5.2.1.1.

5.5.3.4 Cut-and-Fill Terraces

As indicated in Section 5.4.2.2, two terraces will be cut into the southern mine-yard slope during final grading activities. The purpose of these terraces will be to control erosion and ensure stability of the final-graded slope.

5.5.3.5 Highwalls From Previously Mined Areas

Highwalls exist within the permit area that are the result of previous mining operations. These highwalls are the result of surface disturbance in East Spring Canyon by the operator prior to the enactment of SMCRA.

5.5.3.6 Approximate Original Contour

The final reclamation surface is shown on Plate 5-3A&B. This configuration is based on using all available earth materials at the mine site, however several cut slopes will be left along the western edge of the existing pad area based on the following factors:

- o The retained cut slopes are not significantly greater in height or length than the dimensions of existing cliffs and the surrounding area,
- o The residual cut slopes are similar in structural composition to the pre-existing cliffs in the surrounding area and are compatible with the visual attributes of the area, and
- o The residual cut slopes are compatible with the geomorphic processes of the area.

5.5.3.7 Backfilling and Grading - Thin Overburden

No surface coal mining and reclamation activities involving thin overburden occur within the permit area.

5.5.3.8 Backfilling and Grading - Thick Overburden

No surface coal mining and reclamation activities involving thick overburden occur within the permit area.

5.5.3.9 Regrading of Settled and Revegetated Fills

No regrading of settled and revegetated fills is anticipated in the permit area.

5.60 Performance Standards

Coal mining and reclamation operations at the SUFCO Mine will be conducted in accordance with the approved permit and the requirements of R645-301-510 through R645-301-553.

THE ENTIRE TEXT FOR EACH CHAPTER IS INCLUDED IN THIS SUBMITTAL FOR EASE OF REVIEW.

ONCE APPROVED ONLY PAGES WITH CHANGES WILL BE SUBMITTED.

CHAPTER 6

GEOLOGY

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CHAPTER 6

GEOLOGY

6.10 Introduction

This chapter presents a description of the geologic resources in the area of the SUFCO Mine.

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

6.1.1 General Requirements

The geologic resources in the SUFCO Mine area are discussed in Sections 6.2.1 through 6.2.7 of this chapter. The plans for casing and sealing of exploration holes and for subsidence monitoring are addressed in Sections 6.3.1 through 6.3.2.

6.1.2 Certification

All maps, plans, and cross-sections presented in this chapter, required by the regulations, have been certified by a professional engineer.

6.20 Environmental Description

This section presents a description of the geologic resources in the area of the SUFCO Mine.

6.2.1 General Requirements

This section presents the regional and site-specific geologic information for the SUFCO Mine area. The site-specific geologic information for the nearby waste rock disposal site is contained in Volume 3, Part 2.2.

6.2.2 Cross Sections, Maps and Plans

Plate 6-1 presents the surficial geology of the site area, the coal outcrop lines and the strike and dip of the coal seam mined. Plate 6-1 also presents the locations of the drillholes in the mine area. Elevations are given for the drillholes which were logged and sampled. These logs are presented in Appendix 6-1.

The geologic cross-sections, presented on Plate 6-2, 6-3, 6-4 and 6-5, displays the thickness of the coal seams together with their surrounding lithology and the lateral correlation of coal seams using the following drillholes, measured underground mine sections, and measured outcrop sections. (Figure 6-1 presents the generalized stratigraphic section for the mine area.)

- MC-80-16-7
- MC-80-17-8C
- TP-1
- 76-29-Y
- 2L4E (Underground)
- US-77-5
- 76-32-J
- 76-32-I
- US-79-14
- 2R5E (Underground)
- US-79-17
- US-79-10
- US-79-8
- 01-8-1
- MC-80-9-2C
- MC-80-2-1C
- CH-83-6
- MC-80-15-6
- TP-4
- MC-80-13-5C
- WM-82
- DS-97-2
- MC-80-2-1C
- MC-80-12-4
- MC-80-23-10
- TP-3
- UL-77-2
- MC-80-26-13C
- 01-7-1
- 01-9-1
- MC-80-10-3

(Figure 6-1)

Generalized Stratigraphic Section

The Applicant has a Resource Recovery and Protection Plan (R2P2) on file with the Bureau of Land Management. This R2P2 contains a detailed description of the two mineable coal seams on the SUFCO Mine leasehold. The overlying Duncan Seam is not considered mineable (see Section 5.2.2).

There is a plugged and abandoned gas well located in Section 23, T21S, R5E in the Pines Tract. No other oil or gas wells are known to exist within a quarter mile of the mine area. No other water wells have been drilled in the lease area except those drilled by the applicant for the purpose of monitoring the groundwater.

6.2.3 Geologic Determinations

The information required by UDOGM to make a determination of the acid or toxic forming characteristics of the site strata is presented in Section 6.2.4.3 of this M&RP.

The information required by UDOGM to make a determination as to whether the reclamation plan, described in Section 5.40, can be accomplished is presented in Section 6.2.4.

The information required to prepare the subsidence control program is addressed in Section 6.2.4.

6.2.4 Geologic Information

6.2.4.1 Regional Setting

The SUFCO Mine is located beneath the Old Woman Plateau, 20 miles east of Salina, Utah. The Old Woman Plateau lies in the Wasatch Plateau Subprovince of the Colorado Plateau Physiographic Province.

Stratigraphy. All rock units within the SUFCO Mine property boundaries are sedimentary (Plate 6-1 and Figure 6-1). No igneous or metamorphic units are found in the area. Most exposed, consolidated sedimentary rocks in the area were deposited during the Cretaceous Age of the Mesozoic Era. The uppermost North Horn Formation is Upper Cretaceous to lower Tertiary

(Paleocene) in age. The oldest unit is the Upper Cretaceous Masuk Member of the Mancos Shale, which is overlain in order of increasingly younger rocks, by the Star Point Sandstone Member of the Blackhawk Formation; the Upper Blackhawk Formation, the Castlegate Sandstone, the Price River Formation and the overlying North Horn Formation (Figure 6-1).

Mancos Shale-Masuk Member

The Masuk Member of the Mancos Shale has been mapped throughout eastern Utah and western Colorado. The Masuk Member crops out along the entire eastern edge of the Wasatch Plateau and varies in thickness from 300 to 1,300 feet (Davis, and Doelling, 1976). It thins from north to south and from east to west. The Masuk is probably 500 to 600 feet thick in the North Fork of Quitchupah Canyon on the east side of the mine property.

The Masuk Member of the Mancos Shale is the lowest rock unit exposed and consists of blue-gray fissile claystone or silty claystone which weathers light blue-gray to light tan. The unit contains thin calcareous sandy or silty interbeds which increase in frequency toward the top of the unit. The interbeds are usually light tan to yellow, and in places their weathering gives the Masuk a light tan cast. The Member forms the lower slopes of the Convulsion and North Fork Quitchupah Canyons on the south and east sides of the mine property. It forms steep, barren, easily eroded slopes with occasional ledges of more resistant fine-grained sandstone, siltstone, or sandy claystone.

Star Point Sandstone

Exposures of the Star Point Sandstone form a broad, arcuate band crossing eastern Utah and extending into eastern Wyoming, where it is roughly correlative to the Shannon Sandstone of the Cody Shale, and into southwestern Colorado and northeastern New Mexico, where its equivalent is the Point Lookout Sandstone (McGookey, 1973). The Star Point in Utah is almost continuously exposed for about 100 miles along the eastern edge of the Wasatch Plateau (Spieker, 1931).

The unit ranges in thickness to more than 1,000 feet in the Pleasant Valley area in the northern part of the Wasatch Plateau. Eastward, it intertongues and grades with the Mancos Shale until it is absent as a unit near Sunnyside in the Bookcliffs. The unit thins southward along the Wasatch Plateau, and the lowermost units of the Star Point grade into the underlying Masuk Shale (Spieker, 1931). Near the SUFCO Mine property, Bucurel (1977) estimates the Star Point to be about 200 feet thick. The top of the Star Point is nearly planar in the mine area, with the exception of some intertonguing with the overlying Blackhawk Formation (Marley, 1980) in Convulsion Canyon, and again in the Link Canyon-Muddy Creek area northeast of the SUFCO Mine property.

The Star Point Sandstone is a tan to gray, fine- to medium-grained, friable, usually well sorted sandstone, with minor thin interbeds of siltstone or claystone. In places, the upper few feet are bleached white. Marley and Flores (1977) note that the Star Point contains trace fossils, and that siltstones and shales in the unit are intensely bioturbated. Marley et. al. (1979) state that the Star Point Sandstone is a coastal complex of distributary channel, delta front, and beach barrier sediments. The Star Point Sandstone in the mine area is a massive cliff-forming unit which created a nearly unbroken ledge along Convulsion Canyon and North Fork Quitchupah Canyons.

Blackhawk Formation

The Blackhawk Formation outcrops from Thousand Lakes Mountain in south central Utah along the Wasatch Plateau northward to the Bookcliffs, and eastward along the Bookcliffs to a few miles east of Thompson, Utah, in Grand County, where it pinches out. The unit is well exposed along the front of the Wasatch Plateau and in the canyons cutting the Plateau. In the mine area, it is well exposed in Convulsion and Quitchupah Canyons. The Blackhawk Formation varies in thickness from 400 feet, south of John's Peak (Davis, and Doelling, 1976), to 1,750 feet in the Pleasant Valley area (Hintze, 1973) with a general thickening from east to west. On the SUFCO Mine property the Blackhawk varies in thickness from 700 to 830 feet, generally thickening northeastward.

The Blackhawk Formation consists of interbedded alluvial plain and marginal marine deposits of sandstone, siltstone, claystone and coal. Sandstone comprises up to 65 percent of the total thickness of the Blackhawk Formation. 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. There is also a vertical repetition of erosional scours within the upper sandstones (Marley et. al., 1979). The sandstones grade laterally into siltstones and shale. Most of the coal seams in the Blackhawk occur in the lower 200 feet, with the thicker coal seams occurring in the lower 150 feet.

Three coal seams with thickness greater than five feet (the Upper Hiawatha Seam and two others of lesser importance; the Lower Hiawatha Seam and the Duncan Seam) are found in the Blackhawk Formation within the mine property (Figure 6-1). The Upper Hiawatha Seam is the only one of the three which is minable within most of the mine property boundary. This seam has a thickness of between 9 and 18 feet over most of the property but thins sufficiently due to a mid-seam parting in the southeastern portion of the property that it becomes unminable. The Lower Hiawatha Seam occurs in the interval between the Upper Hiawatha Seam and the Star Point Sandstone. It is 2 to 29 feet above the Star Point Sandstone. The interval between the two coal seams varies between 5.6 and 70 feet. The Lower Hiawatha Seam is thin and discontinuous, varying in thickness from 0 to 17.2 feet. The seam is rendered unminable over much of the property due to partings. The Lower Hiawatha seam is only considered to be mineable where the interburden between the Upper Hiawatha seam is greater than 30 feet. This condition and a sufficient mining height occurs only in the northwest corner of the SUFCO Mine property.

The third coal seam occurs 100 to 130 feet above the Upper Hiawatha and has been informally named the Duncan Seam by the SUFCO Mine. The Duncan seam occurs in a small portion of lease U-28297. Because it is of such limited lateral extent, it cannot be correlated with any coal seams in areas surrounding the SUFCO Mine property. It has a maximum thickness of ten feet and is not mineable because of its limited lateral extent. The unsplit area of the Duncan seam is of small extent, probably less than 50 acres. The Duncan zone may correlate with the Muddy coal seam which occurs north of the SITLA lease.

The Upper Member of the Blackhawk Formation generally forms a steep, irregular slope between the cliffs of the underlying Star Point Sandstone and the overlying Castlegate Sandstone. Ledges of sandstone up to 50 feet thick break the slope. In some exposures, the unit is nearly vertical where the Star Point below has sheared off and erosion has not brought the slope to equilibrium. In Convulsion and Quitchupah Canyons, there are large areas of coal burn where the coal has burned naturally and baked the enveloping clays and sandstones to form a resistant reddish clinker layer. These areas are generally steeper than the surrounding slopes. Vegetative cover is generally sparse such that the Blackhawk strata can be easily seen except on some north-facing slopes where vegetation masks the unit.

Castlegate Sandstone

The Castlegate Sandstone extends across the eastern part of Utah, along part of the Bookcliffs and the entire length of the Wasatch Plateau (Spieker, 1931) but loses its character as a cliff-former south of Interstate Highway 70. It is correlative to the Cliffhouse Sandstone of southwestern Colorado and northern New Mexico (McGookey, 1973). In the Wasatch Plateau, its thickness varies from 50 to 500 feet (Spieker, 1931). It is thickest in Price River Canyon at the north end of the Wasatch Plateau. The Castlegate Sandstone is exposed along the rims of Convulsion and North Fork of Quitchupah Canyons. Its thickness varies across the SUFCO Mine property from about 120 to 260 feet with a general northwestward thickening.

The Castlegate Sandstone is a fluvial deposit composed mostly of sandstone, conglomeratic sandstone, pebble conglomerate, and gritstone lenses. There are some thin interbeds of siltstone and claystone, especially toward the base of the unit. The member forms much of the surface of Old Woman Plateau in the southern part of the mine property, and creates a nearly unbroken cliff along the canyons which flank the SUFCO Mine on the south and east.

Price River Formation

The Price River Formation is the uppermost member of the Mesa Verde Group and in the vicinity of the mine it caps the mesa which forms the Old Woman Plateau. The formation is reported to be approximately 550 feet thick in the mine area.

The Price River Formation consists of gray to white gritty sandstone, interbedded with subordinate shale and conglomerate. The formation is resistant to weathering and is a ledge and slope former due to interbedding of resistant sandstones with less resistant shales and claystones.

North Horn Formation

The North Horn Formation straddles the Cretaceous-Tertiary boundary. The maximum thickness of the North Horn within the lease area occurs on Big Ridge where it is estimated to be approximately 430 feet thick. A few seasonal springs are found in the North Horn. The Castlegate Sandstone, other beds of the Price River Formation and the North Horn Formation constitute the cap rock in this area of the Wasatch Plateau.

According to Spieker (1931), the North Horn "consists in the central part of the Plateau predominantly of vari-colored shale, in which the combinations of various shades of red, purple, chocolate-brown, green, and gray are characteristic of the coloring of (correlative) 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, chiefly steel-gray and cream colored but in places also white, tan, and dark blue-gray. In the southwestern, central-eastern, and northern parts of the Plateau the member contains more sandstone. Beds of conglomerate occur in the member irregularly both as to horizon and locality."

Structure. The mine area lies midway between the Joe's Valley-Paradise Fault Zone to the east and the Musinia Fault Zone to the west. Rock units in the mine area strike roughly N40°E and dip 1 to 2 degrees (about 250 feet per mile) to the northwest (Plate 6-1). Local dips may range up to 10 degrees in areas where paleochannels underlying the coal seam cause significant differential compaction. Such local structural variations cannot generally be predicted based on drilling due to the narrow width and sinuous character of these paleochannels found in the lower Blackhawk Formation.

Small displacement faults (apparent vertical displacement of about three feet or less) and some of greater displacement have been encountered and will be encountered as development of the SUFCO Mine progresses. These faults most commonly strike approximately N10° to 15°W and are near vertical. Joints occur parallel and normal to the fault trend.

Geomorphology. The Old Woman Plateau is a gently rolling plateau which is dissected by canyons incised by Quitchupah Creek and its tributaries (Plate 6-1). These canyons are steep-walled and adjacent plateau areas are capped by the Castlegate Sandstone. In the southern part of the mine area, there are areas on the plateau where the nearly flat-lying bedrock forms the surface of the plateau. This structural plain feature is common in the Colorado Plateau. There are also erosional remnants above the plateau surface such as Duncan Mountain and Little Duncan Mountain that are comprised of the Price River Formation and the North Horn Formation. Range terraces were developed on one of the slopes of Little Duncan Mountain during the 1930's.

Tension cracks were developed during the 1970's near East Spring Canyon due to subsidence. These cracks are now mostly healed at the surface by the soil filling them in. Additional subsidence-related tensions cracks have formed within the Pines Lease. Those occurring in soil have healed over time, however, those occurring in the Castlegate Sandstone outcrop are still visible.

Quitchupah and Box Canyon Creeks are perennial and are supplied by springs and ephemeral streams.

Surface and Groundwater Impact. Surface and groundwater impact are discussed in Chapter 7 of this M&RP.

Coal Geology. The coal which is extracted from the SUFCO Mine occurs in the lower portion of the Blackhawk Formation of the Mesa Verde Group of rocks of Upper Cretaceous age. Doelling (1972) identifies the seam as being the Upper Ivie bed while the SUFCO Mine calls it the Upper Hiawatha. The Blackhawk is overlain by the Price River Formation, including the Castlegate Sandstone, and is underlain by the Star Point Sandstone, all being members of the Mesa Verde Group.

The Upper Hiawatha coal seam has quite uniform thickness from southwest to northeast as shown in the Cross-Sections (Plates 6-2, 6-3 and 6-4). North and west of section 7, T22S, R5E, the thickness is also uniform and averages approximately 15 feet. Drillhole information (Appendix 6-1) and Spieker (1931) indicate that the coal thins from Section 7 toward Convulsion Canyon to the southeast. Drillhole data show 6.3 feet of coal in Section 7.

The as-mined quality of the Upper Hiawatha coal seam averages 11,400 BTU, 9.4% ash, 9.5% moisture, 38% volatile matter and 44% fixed carbon.
The Duncan Coal Seam will not be mined as a part of the SUFCO Mine operations because it is discontinuous and has insufficient minable reserves. The Lower Hiawatha Coal Seam will only be mined in the western portion of the Quitchupah lease because this is the only area where the coal is thick enough to mine and there is sufficient interburden between the Upper and Lower Hiawatha

seams to allow mining. The Lower Hiawatha seam may also occur in minable thickness at the northern edge of the SITLA lease but it is not currently under lease (only the Upper Hiawatha seam is under lease).

Greens Hollow Lease - Both the Upper and Lower Hiawatha occur in the lease, the Lower Hiawatha seam has mineable coal thickness throughout the majority of the lease tract and the Upper has mineable thickness in a portion of the lease. The interburden between the Lower Hiawatha and the overlying Upper Hiawatha is considered too thin to mine both seams. Overburden in the area ranges from 1,000 to 2,500 feet. The anticipated mining height ranges from approximately 9 to 15 feet.

The rocks in the Greens Hollow area are sedimentary, with the exposed units being the Blackhawk, Castlegate Sandstone, Price River, North Horn and Flagstaff Limestone in ascending order. Refer to General Stratigraphy, Figure 1 and Geologic Fence Diagram ,Map 2, in the Geology Technical Report found in Appendix 6-4. Subsurface units include Mancos Shale and Star Pont Sandstone. Much of the topography exhibits mass movement including landslides, slumps, rock falls, thin alluvium in canyon bottoms and incised moderate to deeply eroded stream channels.

Cross-Sections, Maps and Plans. The cross-sections and maps are discussed in Section 6.2.4 and are located at the end of this chapter. The applicant request's that this information remain confidential.

Drill Logs and Chemical Analyses. See Section 6.2.4.3 and Appendices 6-1 and 6-2. The applicant requests that this information remain confidential and that public access to these sections be limited to only persons with an interest which is or may be adversely affected as provided under Section 40-10-10(4) of the Act.

6.2.4.2 Test Boring and Drillhole Data (overburden removed)

SUFCO Mine does not plan to remove any overburden above the coal seam to be mined. Regulations related to overburden removal do not apply to this M&RP.

6.2.4.3 Test Boring and Drillhole Data (overburden not removed)

The drill logs and chemical analyses required by regulations R645-301-624.310 through R645-301-624.330 are presented in Appendices 6-1 and 6-2.

Lithologic Logs. Lithologic logs of drillholes are presented in Appendix 6-1. The applicant requests that this information be kept confidential and that public access to these sections be limited to only persons with an interest which is or may be adversely affected as provided under Section 40-10-10(4) of the Act.

Acid, Toxic, and Alkaline Chemical Analyses (above and below the coal seam). Chemical analyses for acid- and toxic-forming and alkalinity-producing materials from the waste rock disposal site and roof and floor rock material from drill cores is presented in Appendix 6-2. Using Table 2 in the Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining (Appendix 6-3), only two unacceptable values have been reported. Samples of material placed in the waste rock disposal site are taken regularly and analyzed quarterly and are considered to be representative of the coal, roof, floor, and partings. The boron concentration of the waste rock disposal site sample taken in the second quarter of 1991 exceeds the acceptable level of 5.0 ppm by only 0.44 ppm; therefore, this boron value is not of significant concern. Secondly, the SAR value of 19.30 for the Upper Hiawatha coal seam in drillhole 89-20-2 is unacceptable. However, as there have been no other unacceptable SAR values since this sample was taken, it is probably due to contamination, lab error or sampling error. Analytical results of all other samples are acceptable.

Acid, Toxic, and Alkaline Chemical Analyses (coal seam). The chemical analyses discussed above are also representative of the coal seam mined. Additionally, analyses of pyrite and sulfur forms have been performed on roof, parting, and floor samples taken from various core holes. The results of these analyses are reported in Appendix 6-2.

Properties of Rocks in Room and Pillar Areas. Room and pillar mining is now only used in the stream buffer zones and beneath escarpments to prevent subsidence. Pillars are not removed in these areas.

The clay content of floor and roof rock samples from two drill holes was determined analytically (see Appendix 6-2) but otherwise clay content is based on description of cores. The lithology of the stratum immediately below the minable coal varies from drillhole to drillhole. Therefore, the clay content will range from almost 100% (pure claystone) to less than 5% (submature or mature sandstone). Drillholes 74-36-5, 76-28-K, 76-29-Y, US-79-14, US-79-15 and US-81-4 penetrate the stratum immediately below the coal seam to be mined. Lithologic logs for these drillholes (which include lithotypes of the stratum immediately below the coal seam to be mined) are presented in Appendix 6-1. No engineering properties for the underlying claystone have been determined, because its friable nature makes it next to impossible to prepare samples.

6.2.5 Additional Geologic Information

It is not anticipated that any additional geologic data will need to be collected for this site.

6.2.6 Sampling Waivers

SUFCO Mine does not request a sampling waiver for this site.

6.2.7 Description of the Overburden Thickness and Lithology

Overburden thickness above the coal seam varies due to the plateau and canyon-type topography from approximately 600 to 1800 feet and averages about 900 feet. Stratigraphically, the overburden consists of the Upper Blackhawk Formation which contains the coal seams, the Castlegate Sandstone, the Price River Formation, and the North Horn Formation, as described in Section 6.2.4.1 of this M&RP.

6.30 Operation Plan

6.3.1 Casing and Sealing of Exploration Holes

The information addressing regulations for casing and sealing of exploration holes is found in Section 7.6.5 of this M&RP. This includes both the temporary and permanent casing and sealing of exploration holes. 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.

6.3.2 Subsidence Monitoring

Subsidence and subsidence monitoring points are discussed in detail in Section 5.2.5 of this M&RP. The extent of the subsidence is shown on Plate 5-10. Subsidence monitoring is performed on an annual basis and the results of the monitoring are reported in the annual report.

Surface cracking related to mine subsidence has occurred above the existing mine workings at the Sufco mine. The cracks are surveyed and illustrated on the Mine Subsidence Map included in the annual report. Subsidence cracks that form due to mining generally occur over mined panels and above the inside edges of the gateroads. Where the overlying topography is relatively flat, such as in the Pines tract, cracks will form in the soils and bedrock parallel, sub-parallel and perpendicular to the long axis of the panel. In this type of area, the cracks will typically have minimal aperture and minor vertical offset. Subsidence in areas of the Quitchupah and Pines Tract where a deep drainage with steep canyon walls capped by Castlegate Sandstone exist, cracks have formed parallel to the drainage rim and may or may not be parallel to the axis of the panel. Occasionally, these cracks remain open after subsidence is complete. Sufco has repaired several cracks on the rim above the East Fork of Box Canyon where it was determined they presented a safety hazard.

Where bedrock is exposed at the surface and the local joint pattern is evident, subsidence fractures appear to be parallel or sub-parallel to the orientation of the panel. The cracks typically form an en echelon pattern on either side of the joint and may intersect with the joint. After the crack intersects the joint, it will travel within the joint itself for a short distance. However, the crack will reappear in the bedrock again outside of the joint as the en echelon pattern continues. In the Pines Tract and Quitchupah areas, jointing generally does not appear to have significant effect on the location or propagation of subsidence related fractures. Exceptions to this occur where the Castlegate Sandstone has been subsided at or near the rim of steep drainages or canyons. In these areas, large blocks of sandstone have been observed to rotate toward the drainage during subsidence. Often, after subsidence is complete, the blocks remain at their new attitudes leaving an opening between the block and the in-place sandstone. Where the aperture is deemed hazardous, Sufco has backfilled the openings.

Subsidence in the Muddy tract area will occur in the Price River and North Horn Formations. Because these formations consist of ledge/slope forming interbedded sandstone, siltstone, shale and limestone and are typically overlain by a mantle of soil, little bedrock is exposed at the surface. Therefore, it would be difficult to determine the relationship of subsidence crack formation and bedrock jointing. It would be appropriate to assume, however, that subsidence cracks will form in this tract similarly to those found in the previously mined and subsided areas of the Sufco mine.

6.3.3 Exploration Drilling

The purpose of exploration drilling is to obtain stratigraphic and coal quality information to make for more accurate mine planning and maintain a high level of miner safety. The exploration area is located within the current mining lease boundary of Permit C/041/0002 as shown on Plate 6-1. The SUFCO Mine is planning to drill approximately 10 drill holes over the next 5 years. In the case of the SITLA lease, drilling will be conducted as approved under a Division-approved Minor Coal Exploration Permit. As in the past, drilling on federal leases with USFS administered surface will continue to be permitted through the BLM Exploration Plan process. The SUFCO Mine understands that UDOGM, the BLM, and the USFS all have a important roles in approval of drilling and will continue to work diligently to ensure requirements of all involved agencies are met prior to conducting surface exploration work.

Drill site preparation, drilling, and final reclamation work will last approximately two weeks per year. Reclamation will be concurrent with drilling to minimize the duration of the project.

The type of exploration to be used is rotary drilling or continuous wireline core drilling using a 2,000 ft rated drill rig. The drilling procedure for rotary drilling will be as follows: rotary drill using a tri-cone bit to core point, core the coal intervals using air with a diamond or carbide bit, ream the cored interval and rotary drill to total depth. Air will be used as a drilling medium as much as possible though conditions may warrant water, foam or mud. The drilling procedure for continuous wireline core drilling will be as follows: continuous core drill through total depth. Drilling medium will be water, polymer, and/or mud. Upon completion of drilling, the holes will be geophysically logged then plugged the full depth with concrete or a combination of concrete and bentonite hole plug or abandonite as approved by the BLM. A total of up to 4.0 acre-feet of water will be pumped from the North and/or South Fork of Quitchupah Creek, Muddy Creek , or the Sufco minesite for use during drilling and hole plugging operations. No coal will be removed beyond that which is cored.

Some of the drill sites will be accessed using existing wheel tracks or over the existing surface and a few will require that new roads be built off of U. S. Forest Service roads or existing wheel tracks . Helicopter-supported drilling techniques will also be utilized at times to minimize surface impacts.

The drill sites will be approximately 80 feet by 100 feet in size. One half of the site will be for the drill rig and water truck while the other half will have 1 to 2 mud pits and temporary supply storage.

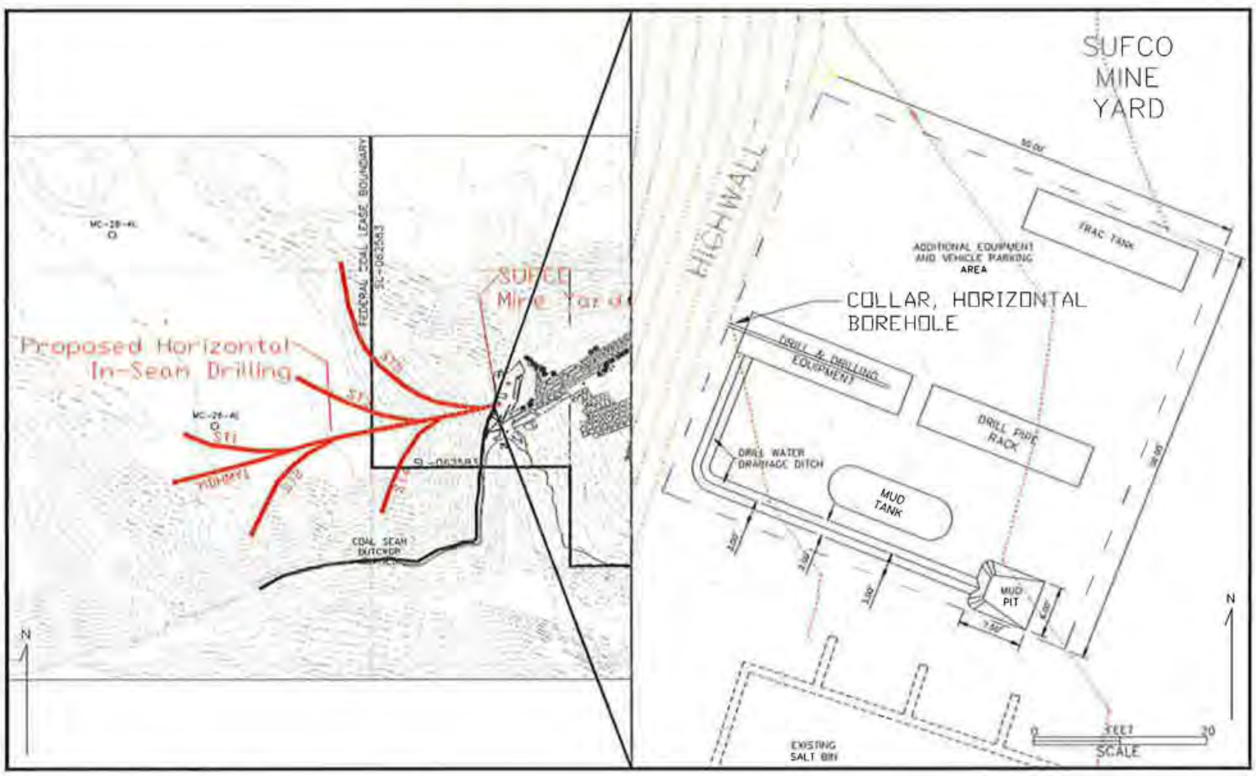
The applicant requests that any information from exploration drilling be kept confidential and that public access to any of the information be limited to only persons with an interest which is or may be adversely affected as provided under Section 40-10-10 (4) of the Act.

Mine Yard Directional Horizontal Burn Drilling

One horizontal directional exploration drillhole will be drilled from within the permitted Sufco minesite at a location shown on Figure 6-2. This drillhole will be drilled to determine coal burn location west of the Sufco minesite for mine planning purposes. The directional drillhole will be nominally 3.8 inch and will be drilled almost entirely within the Upper Hiawatha coal seam. Only minor excavation of existing mine yard fill material will occur on the existing permitted Sufco minesite. A small ditch and mudpit/sump will be constructed to contain drill water and fluids. Drill fluids will be recycled as much as possible. Drilling fluid additives will be minimal and nontoxic.

Excess fluids and cuttings will be hauled to an approved waste disposal site. The mudpit will be constructed in such a way as to allow easy access for cleaning and hauling away cuttings (Figure 6-2). Cuttings will be hauled to Sufco Mine's permitted waste rock site along the Sufco haul-road to the southwest. Drill water will be supplied by the existing minesite water system. Upon completion, the drill hole collar will be plugged with a cement or grout to a depth of approximately 100 ft. Drilling is planned to begin on approximately April 30, 2008, and be completed by June 30, 2008. Upon completion all equipment will be removed and the yard fill smoothed out. No surface or vegetation disturbance or change in runoff will occur since the work is being conducted on the permitted minesite.

Figure 6-2. Location and approximate setup of directional horizontal drillsite within the permitted



Sufco minesite area.

A second horizontal exploration drill hole will be drilled from within the permitted Sufco mine site at a location shown on Figure 6-3. The drill hole will be drilled to determine coal burn and coal temperature west of the Sufco mine site for mine planning purposes. The directional drill hole will be nominally 3.8 inch and will be drilled in strata above the upper Hiawatha seam and with the Upper Hiawatha seam. Only minor excavation of existing mine yard fill material will occur on the existing permitted Sufco mine site. A small ditch and mudpit/sump will be constructed to contain drill water and fluids. Drill fluids will be recycles as much as possible. Drilling fluid addictive will be minimal and nontoxic. Excess fluids and cuttings will be hauled to an approved waste disposal site. The mudpit will be constructed in such a way as to allow easy access for cleaning and hauling away cuttings (Figure 6-3). Cutting will be hauled to Sufco's permitted waste rock site along the Sufco haul-road to the southwest. Drill water will be supplied by the exiting mine site water system. The north side track will be cased into the old Convulsion Canyon Mine for monitoring of mine atmosphere. A valve will be installed at the collar to allow monitoring and atmospheric sampling. Upon completion of monitoring activities the dill hole collar will be plugged with a cement or grout to a depth of approximately 50 ft. Drill in planned to begin on approximately December 9, 2009, and be completed by February 26, 2010. Upon completion all equipment will be removed and the yard fill smoothed out. No surface or vegetation disturbance or change in runoff will occur since the work is be conducted on the permitted mine site.

Figure 6-3. Location and approximate setup of second direction horizontal drill sit within the permitted Sufco mine site area.

6.3.4 Exploration Hole Reclamation

The exploration holes will be filled with concrete or concrete/hole plug-abandonite slurry through their full depth after exploration activities are completed. Concrete will be used through all minable coal zones. This will be done by pumping concrete or slurry through the drill pipe which hangs 40-

60 ft. off the bottom of the hole until the hole up to the drill pipe is filled. The drill pipe is then tripped-out another 40-60 ft. and more concrete or slurry is pumped into the hole. This process is repeated until the full depth of the hole is filled and good drill hole wall to concrete/hole plug-abandonite contact is assured.

6.40 Performance Standards

6.4.1 Exploration and Drillholes

The performance standards used in the casing and sealing of all exploration holes and drillholes are outlined in Section 7.6.5 of this M&RP.

6.4.2 Monuments and Surface Markers of Subsidence Monitoring Points

The performance standards used in the reclamation of all monuments and surface markers used as subsidence monitoring points are outlined in Section 5.2.5.

6.4.3 Exploration Drilling

6.4.3.1 Exploration Activities

During drill site preparation, drilling and reclamation, any trash or contamination that may result from these activities, will be removed from the site. Trash and contaminants will be disposed of in an approved disposal site.

No heavy equipment will be moved if the ground is soft and rutting potential exists. All travel will stay within a twelve-foot wide track. All drilling and related equipment will be promptly removed from the exploration area when no longer needed.

The applicant's representative will, while in the exploration area, have a copy of the Division Approval for Exploration within the permit area available for review.

6.4.3.2 Soils

Where topsoil and subsoil are removed for drill site construction the methods described in Chapter 2 Soils Section 2.3.1.1 will be followed. Soil will be salvaged to at least a 12 inch depth or the full soil depth from drill sites and constructed roads to consolidated material, whichever is less. Wheel tracks used to access drill sites are considered minor disturbance as described in R645-301-232.400 and will be treated as described in Chapter 2 Soils Section 2.3.2.4. Due to the short time topsoil and subsoil will be stockpiled and the small amount stockpiled, it will not be vegetated. All topsoil and subsoil stockpiles will be completely surrounded by a properly constructed silt fence.

Soil from constructed roads will be salvaged by pushing it into a berm and protected by diverting water away from the berm. The soil in wheel tracks will be ripped then scarified prior to reseeding.

6.4.3.3 Biology

The performance standards described in Chapter 3 Biology Section 3.5 will be followed during drill site and wheel track reclamation. A raptor survey will be done in the Spring/early Summer of 2005 and the new information will be used to ensure that nesting sites are not disturbed during drilling. Exploration activities (drilling, dirt work and reclamation) will only occur between August 1 and December 1 unless otherwise approved by involved agencies. The mitigation requested by the U. S. Forest Service NEPA documentation for the loss of water from the North Fork of Quitchupah Creek will be satisfied. No trees having cavities which could be used by nesting migratory birds of high federal interest will be removed during the exploration activities.

6.4.3.4 Hydrology

The performance standards described in Chapter 7 Hydrology will be followed where applicable during the exploration period. Though sediment yield will be negligible, sediment from drill sites will be controlled by either a properly constructed silt fence located at the lowest point on each drill site or by diverting all run-off from each drill site into the mud pit. Sediment from topsoil and subsoil stockpiles will be controlled by a silt fence around their base.

Sedimentation control from newly built temporary roads will meet that described in R 742-410 while the roads are in use. Reclamation of those roads will follow that described in Chapter 7 Hydrology, Section 7.60, to ensure post-use sedimentation control.

6.4.3.5 Archaeology

An archaeological survey will be conducted prior to site preparation, drilling activities and use of wheel tracks for those areas which have not been previously surveyed. Should cultural or historical resources be found during these activities the activity will be stopped and the UDOGM notified.

6.4.3.6 Acid or Toxic-Forming Materials

No acid or toxic-forming materials have been encountered previously and thus are not expected to be encountered during this drilling program. The addition of suspended solids to streams will be negligible due to the small areas disturbed, the short life of the drilling program and sediment control measures that will be used.

6.50 Reclamation

6.5.1 Wheel Tracks and Drill Sites

Wheel tracks will be reclaimed by ripping followed by scarifying the soil and reseeding. Drill sites will be reclaimed by first replacing the material excavated for the mudpits, distributing the soil, and lastly reseeding. The seed mix to be used is as follows (as approved by USFS during 2004 drilling):

		Pounds PLS/Acre
Western Wheatgrass	Elymus smithii	2
Basin Wild Rye	Elymus cinereus	1
Blue Bunch Wheatgrass	Agropyron Spicatum	2
"Paiute" Orchardgrass	Dactylis glomeratus	1
Intermediate Wheatgrass	Agropyron (elymus) intermedium	2
Ladak Alfalfa	Medicago sativa Var Ladak	1
Small Burnet	Sanguisorba minor	1
Silvery Lupine	Lupinus argenteus	0.75
Mountain Aster	Aster adscendens	0.25

The seed mixture certificate will state seed germination test date, germination rate, and elevation, county and state of origin. The seed will be sold in compliance with the State Seed Act. U. S. Forest Service certified noxious weed free straw or hay will be used as mulch.

Revegetation success will be determined using the Erosion Condition Classification System developed by OSMRE and by comparison to established reference areas. The reference areas will be undisturbed areas of a similar vegetative type adjacent to the drill sites. Equipment used to reclaim wheel tracks, build roads and drill sites will be either a D-7 or D-8 size dozer or a road grader to fill mud pits, redistribute soils, and rip and scarify wheel tracks.

6.5.2 Permanent Casing and Sealing of Wells

All drill holes will be plugged with concrete as described in Chapter 7 Hydrology section 7.6.5. A permanent marker will be placed at the top of each drill hole bearing the drill hole number.

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Spieker, E.M. 1931. The Wasatch Plateau Coal Field, Utah. USGS Bull. 819, p 46.

SUFCO Mine. Personal communication by Larry Trimble, field reconnaissance. Salina, Utah.

U.S. Department of the Interior, Final Supplemental Impact Statement for Leasing and Underground Mining of the Greens Hollow Federal Coal Lease Tract UTU-84102, Sanpete and Sevier Counties, Utah, February 2015

APPENDIX 6-4

Greens Hollow Tract

GEOLOGY
TECHNICAL REPORT
GREENS HOLLOW COAL LEASE TRACT

Prepared for:
Bureau of Land Management
Price Field Office
125 South 600 West
Price, Utah 84501

Manti-La Sal National Forest
599 West Price River Drive
Price, Utah 84501

Fishlake National Forest
115 East 900 North
Richfield, Utah 84701

Prepared by:
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807 E. South Temple #200
Salt Lake City, Utah 84102

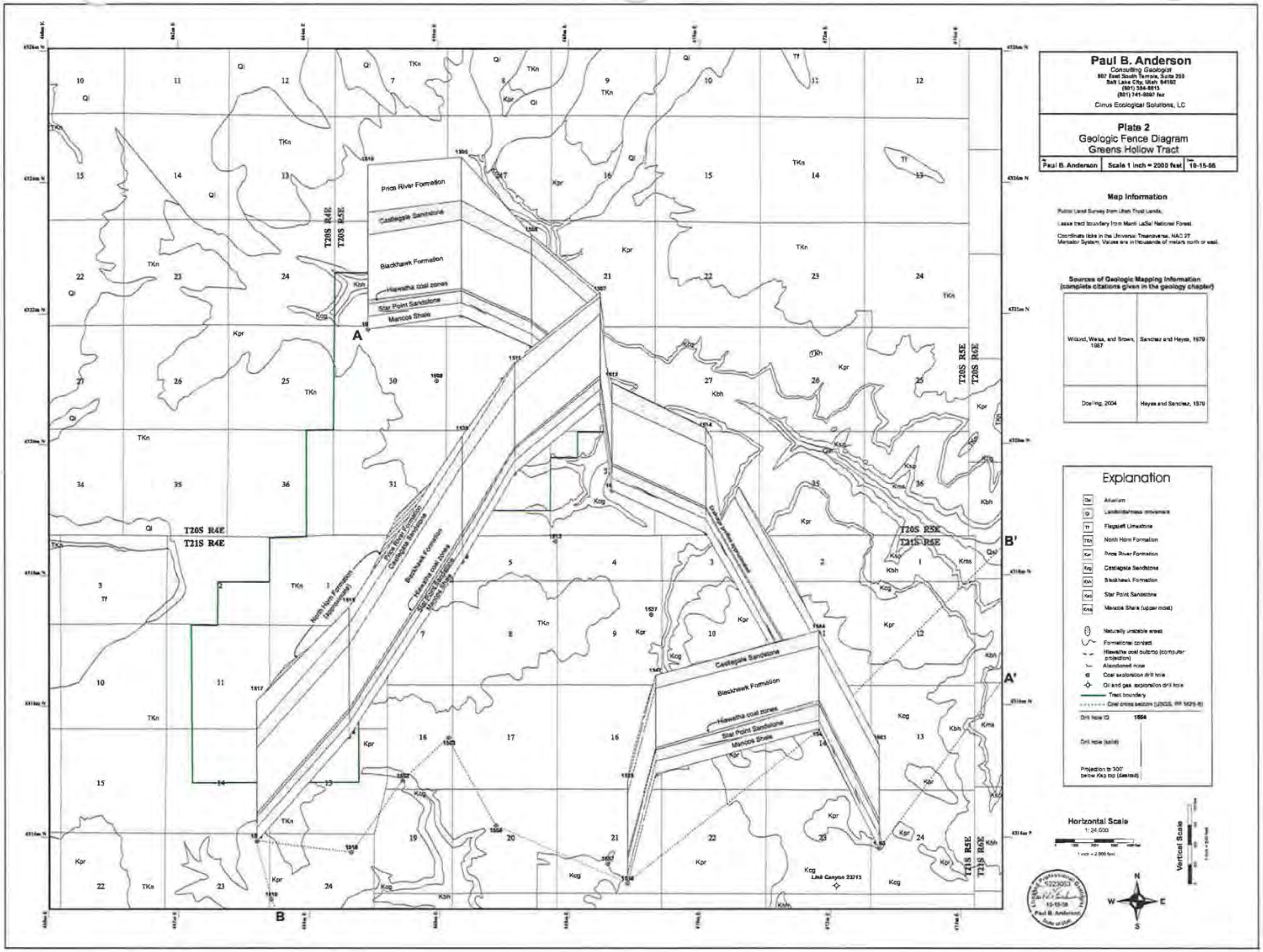
Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, Utah 84321

2014

Maps, Plates, and Figures

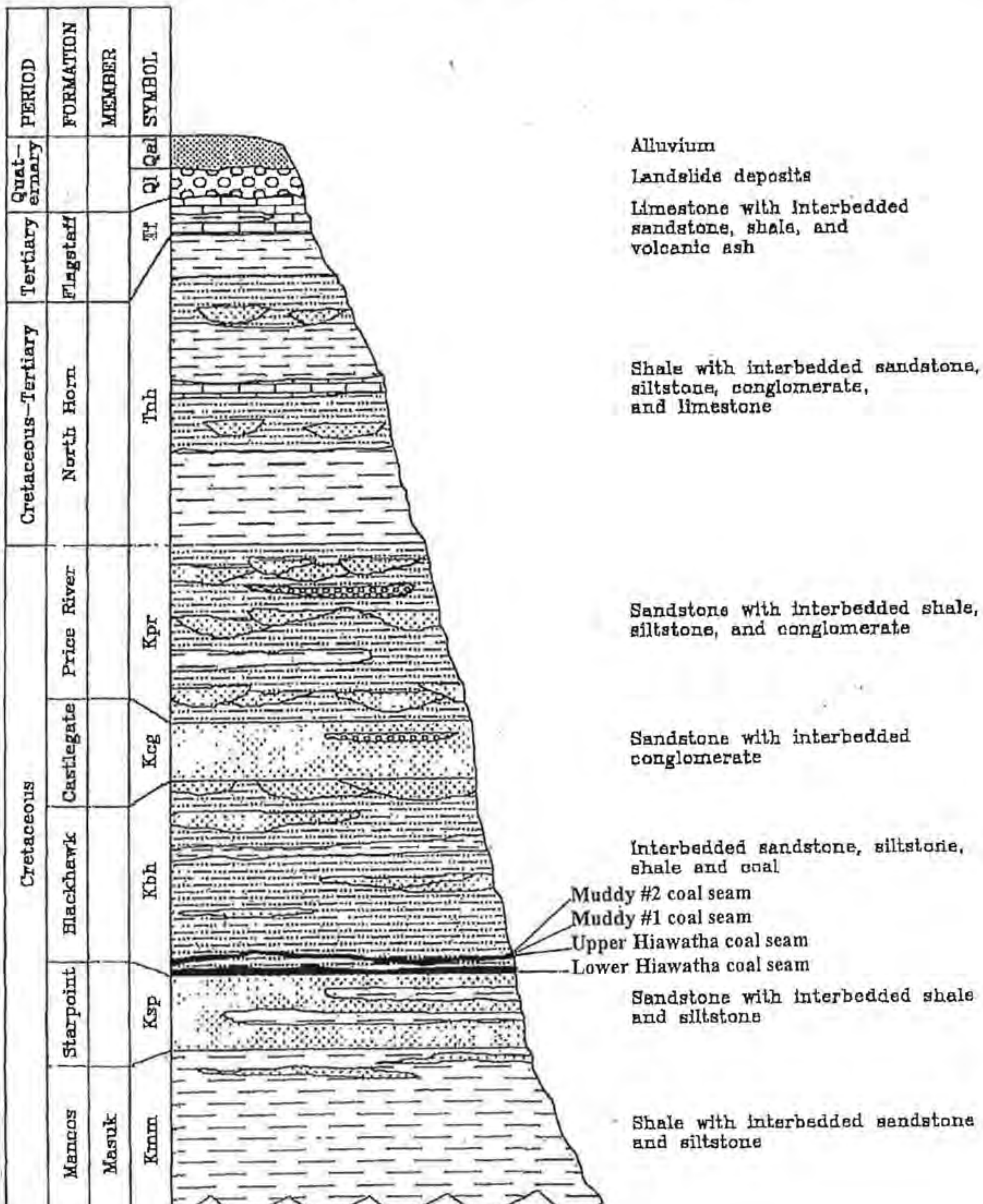
5.0 LIST OF PREPARERS WITH QUALIFICATIONS OF PREPARERS

Paul B. Anderson, Consulting Geologist, Salt Lake City, Utah Mr. Anderson is a licensed professional geologist in the State of Utah (#5223053), has a B.S. and Master's Degree in geology, has worked directly for the coal industry in Utah for 6 years, for a oil and gas exploration company for 5 years, and consulted as a geologist addressing fossil fuel resources, ground water, and environmental issues for a variety of clients, both government and private for 22 years.



Paul B. Anderson
Consulting Geologist
Cirrus Ecological Solutions, LC
Plate 2
Geologic Fence Diagram
Greens Hollow Tract
Paul B. Anderson
Scale 1 inch = 2000 feet
10-15-08
Map Information
Lease tract boundary from Manti LaSal National Forest.
Sources of Geologic Mapping Information
(complete citations given in the geology chapter)
Witkind, Weiss, and Brown, 1987
Sanchez and Hayes, 1979
Doelling, 2004
Hayes and Sanchez, 1979
Explanation
Alluvium
Flagstaff Limestone
North Horn Formation
Price River Formation
Castlegate Sandstone
Blackhawk Formation
Star Point Sandstone
Mancos Shale (upper most)
Formational contact
Abandoned mine
Coal exploration drill hole
Oil and gas exploration drill hole
Tract boundary
Drill hole ID
Drill hole (solid)
Projection to 300' below Ksp top (desired)
Horizontal Scale
1:24,000
Vertical Scale
Price River Formation
Castlegate Sandstone
Blackhawk Formation
Hiawatha coal zones
Star Point Sandstone
Mancos Shale
North Horn Formation
T20S R4E
T20S R5E
T21S R4E
T21S R5E
T20S R6E
T21S R6E
A
A'
B
B'
Link Canyon 23715
N
W
E
S

Figure 1.
General Stratigraphy of the Greens Hollow Coal Lease Tract



APPENDIX A: SUPPORTING DATA

Greens Hollow Tract Air Photo Fracture Pattern Analysis

Tract + Buffer, North-Trending Quadrant Fracture Data Values

Air Photo ID	Area Designation (Public Land Survey System, Salt Lake Base and Meridian)				Stratigraphic Unit	Fracture Analysis Air Photo scale is 1:17500 (9 measures) * Use Engineer's 30 scale (1" = 1500', with smallest division = 50')			360		Assume
Line - Photo ID	1/4 1/4	Section	Township	Range	all uppermost Castlegate	ID #	Quadrant (N=315-45 E=45-135)	Orientation (0 - 359)	Orientation (-45 to +45)	Length* (ft)	Spacing* (ft)
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate	9	N	0	-360	100	
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate	10	N	0	-360	75	50
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate	11	N	0	-360	75	
200-184	sw 1/4	12	21S	5E	uppermost Castlegate	34	N	329	-31	175	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	13	N	329	-31	200	30
200-185	e 1/2	11	21S	5E	uppermost Castlegate	14	N	329	-31	200	
600-137	nw 1/4	23	21S	5E	uppermost Castlegate	24	N	330	-30	175	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	6	N	331	-29	200	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	7	N	331	-29	175	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	8	N	331	-29	275	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	15	N	331	-29	200	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	25	N	331	-29	75	30
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	26	N	331	-29	150	50
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	27	N	331	-29	100	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	28	N	331	-29	200	
200-184	sw 1/4	12	21S	5E	uppermost Castlegate	33	N	331	-29	175	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	22	N	331	-29	175	
100-42	sw se	21	21S	5E	uppermost Castlegate	36	N	332	-28	525	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	9	N	332	-28	150	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	11	N	332	-28	175	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	24	N	332	-28	375	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	18	N	332	-28	175	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	1	N	333	-27	250	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	2	N	333	-27	100	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	3	N	333	-27	200	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	4	N	333	-27	125	
600-137	nw 1/4	23	21S	5E	uppermost Castlegate	25	N	333	-27	300	
600-137	nw 1/4	23	21S	5E	uppermost Castlegate	26	N	333	-27	175	
100-42	se nw	20	21S	5E	uppermost Castlegate	9	N	334	-26	275	30
100-42	se nw	20	21S	5E	uppermost Castlegate	10	N	334	-26	575	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	4	N	334	-26	225	40
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	5	N	334	-26	150	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	10	N	334	-26	150	
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600-137	se 1/4	15	21S	5E	uppermost Castlegate	8	N	334	-26	175	
100-42	se nw	20	21S	5E	uppermost Castlegate	21	N	335	-25	250	
100-42	se nw	20	21S	5E	uppermost Castlegate	31	N	335	-25	225	
100-42	se nw	20	21S	5E	uppermost Castlegate	32	N	335	-25	150	
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600-137	ne sw	22	21S	5E	uppermost Castlegate	30	N	335	-25	200	
100-38	e 1/2	33	20S	5E	uppermost Castlegate	22	N	335	-25	200	
100-38	e 1/2	33	20S	5E	uppermost Castlegate	23	N	335	-25	175	
100-38	e 1/2	33	20S	5E	uppermost Castlegate	24	N	335	-25	150	

Greens Hollow Tract Air Photo Fracture Pattern Analysis

360

Tract + Buffer, North-Trending Quadrant Fracture Data Values

Air Photo ID	Area Designation (Public Land Survey System, Salt Lake Base and Meridian)				Stratigraphic Unit	Fracture Analysis — Air Photo scale is 1:17500 (9 measures) * Use Engineer's 30 scale (1" = 1500', with smallest division = 50')					Assume
Line - Photo ID	1/4 1/4	Section	Township	Range	all uppermost Castlegate	ID #	Quadrant (N=315-45 E=45-135)	Orientation (0 - 359)	Orientation (-45 to +45)	Length* (ft)	Spacing* (ft)
100-42	se nw	20	21S	5E	uppermost Castlegate	26	N	336	-24	200	
100-42	se nw	20	21S	5E	uppermost Castlegate	27	N	336	-24	225	
100-42	sw se	21	21S	5E	uppermost Castlegate	35	N	336	-24	150	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	31	N	336	-24	200	30
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	32	N	336	-24	125	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	23	N	336	-24	300	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	24	N	336	-24	225	
600-137	ne sw	22	21S	5E	uppermost Castlegate	34	N	336	-24	100	50
600-137	ne sw	22	21S	5E	uppermost Castlegate	35	N	336	-24	100	
600-137	ne sw	22	21S	5E	uppermost Castlegate	39	N	336	-24	100	
600-137	ne sw	22	21S	5E	uppermost Castlegate	40	N	336	-24	75	
600-139	w 1/2	3	21S	5E	uppermost Castlegate	2	N	336	-24	175	
600-139	w 1/2	3	21S	5E	uppermost Castlegate	11	N	336	-24	300	
100-36	ne sw	21	20S	5E	uppermost Castlegate	8	N	337	-23	300	
100-42	w1/2 sw	20	21S	5E	uppermost Castlegate	2	N	337	-23	225	
100-42	n1/2 nw	20	21S	5E	uppermost Castlegate	3	N	337	-23	300	
100-42	se nw	20	21S	5E	uppermost Castlegate	15	N	337	-23	425	
100-42	se nw	20	21S	5E	uppermost Castlegate	16	N	337	-23	300	
100-42	se nw	20	21S	5E	uppermost Castlegate	28	N	337	-23	250	
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200-184	ne 1/4	11	21S	5E	uppermost Castlegate	2	N	337	-23	275	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate	3	N	337	-23	175	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	8	N	337	-23	150	50
200-185	e 1/2	11	21S	5E	uppermost Castlegate	9	N	337	-23	175	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	10	N	337	-23	175	
600-137	ne 1/4	22	21S	5E	uppermost Castlegate	17	N	337	-23	200	
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100-42	n1/2 nw	20	21S	5E	uppermost Castlegate	5	N	338	-22	350	
100-42	se nw	20	21S	5E	uppermost Castlegate	22	N	338	-22	200	
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200-185	e 1/2	11	21S	5E	uppermost Castlegate	19	N	338	-22	250	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	20	N	338	-22	150	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	21	N	338	-22	250	
600-137	se 1/4	15	21S	5E	uppermost Castlegate	6	N	338	-22	200	
600-137	se 1/4	15	21S	5E	uppermost Castlegate	7	N	338	-22	175	

Greens Hollow Tract Air Photo Fracture Pattern Analysis										360		
Tract + Buffer, North-Trending Quadrant Fracture Data Values												
Air Photo ID	**Area Designation** (Public Land Survey System, Salt Lake Base and Meridian)				**Stratigraphic Unit**		**Fracture Analysis** Air Photo scale is 1:17500 (9 measures) * Use Engineer's 30 scale (1" = 1500', with smallest division = 50')					Assume
Line - Photo ID	1/4 1/4	Section	Township	Range	all uppermost Castlegate		ID #	Quadrant (N=315-45 E=45-135)	Orientation (0 - 359)	Orientation (-45 to +45)	Length* (ft)	Spacing* (ft)
600-137	nw 1/4	23	21S	5E	uppermost Castlegate		23	N	338	-22	150	
600-137	ne sw	22	21S	5E	uppermost Castlegate		27	N	338	-22	200	
600-137	ne sw	22	21S	5E	uppermost Castlegate		28	N	338	-22	250	
600-137	ne sw	22	21S	5E	uppermost Castlegate		41	N	338	-22	225	
100-36	se nw	21	20S	5E	uppermost Castlegate		1	N	339	-21	150	40
100-36	se nw	21	20S	5E	uppermost Castlegate		2	N	339	-21	425	40
100-36	se nw	21	20S	5E	uppermost Castlegate		3	N	339	-21	200	50
100-36	se nw	21	20S	5E	uppermost Castlegate		4	N	339	-21	200	50
100-36	se nw	21	20S	5E	uppermost Castlegate		5	N	339	-21	175	
100-36	se nw	21	20S	5E	uppermost Castlegate		6	N	339	-21	100	
100-42	se nw	20	21S	5E	uppermost Castlegate		29	N	339	-21	575	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		19	N	339	-21	150	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		22	N	339	-21	125	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		23	N	339	-21	200	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		29	N	339	-21	175	30
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		30	N	339	-21	200	
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate		16	N	339	-21	250	
600-137	ne 1/4	22	21S	5E	uppermost Castlegate		12	N	339	-21	200	60
600-137	ne 1/4	22	21S	5E	uppermost Castlegate		13	N	339	-21	150	
600-137	ne 1/4	22	21S	5E	uppermost Castlegate		14	N	339	-21	325	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate		13	N	339	-21	150	
600-138	w 1/2	15	21S	5E	uppermost Castlegate		28	N	339	-21	325	
600-138	w 1/2	15	21S	5E	uppermost Castlegate		29	N	339	-21	250	50
600-138	w 1/2	15	21S	5E	uppermost Castlegate		30	N	339	-21	200	
600-138	w 1/2	15	21S	5E	uppermost Castlegate		31	N	339	-21	275	
600-139	w 1/2	3	21S	5E	uppermost Castlegate		10	N	339	-21	100	
100-38	nw se	33	20S	5E	uppermost Castlegate		11	N	339	-21	200	40
100-38	nw se	33	20S	5E	uppermost Castlegate		12	N	339	-21	150	
100-42	n1/2 nw	20	21S	5E	uppermost Castlegate		4	N	340	-20	225	
100-42	se nw	20	21S	5E	uppermost Castlegate		6	N	340	-20	375	
100-42	se nw	20	21S	5E	uppermost Castlegate		14	N	340	-20	225	
100-42	se nw	20	21S	5E	uppermost Castlegate		30	N	340	-20	275	
100-42	sw se	21	21S	5E	uppermost Castlegate		34	N	340	-20	500	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		12	N	340	-20	250	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		16	N	340	-20	200	60
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		17	N	340	-20	150	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		18	N	340	-20	400	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		20	N	340	-20	500	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		21	N	340	-20	250	
200-185	e 1/2	11	21S	5E	uppermost Castlegate		16	N	340	-20	150	30
200-185	e 1/2	11	21S	5E	uppermost Castlegate		17	N	340	-20	175	
200-185	e 1/2	11	21S	5E	uppermost Castlegate		25	N	340	-20	75	
200-185	e 1/2	11	21S	5E	uppermost Castlegate		26	N	340	-20	325	

Greens Hollow Tract Air Photo Fracture Pattern Analysis									360		
Tract + Buffer, North-Trending Quadrant Fracture Data Values											
Air Photo ID	**Area Designation** (Public Land Survey System, Salt Lake Base and Meridian)				**Stratigraphic Unit**	**Fracture Analysis** Air Photo scale is 1:17500 (9 measures) * Use Engineer's 30 scale (1" = 1500', with smallest division = 50')					Assume
Line - Photo ID	1/4 1/4	Section	Township	Range	all uppermost Castlegate	ID #	Quadrant (N=315-45 E=45-135)	Orientation (0 - 359)	Orientation (-45 to +45)	Length* (ft)	Spacing* (ft)
600-137	se 1/4	15	21S	5E	uppermost Castlegate	1	N	340	-20	175	
600-137	se 1/4	15	21S	5E	uppermost Castlegate	2	N	340	-20	150	
600-137	se 1/4	15	21S	5E	uppermost Castlegate	3	N	340	-20	200	
600-137	se 1/4	15	21S	5E	uppermost Castlegate	4	N	340	-20	125	
600-137	ne 1/4	22	21S	5E	uppermost Castlegate	15	N	340	-20	325	40
600-137	ne 1/4	22	21S	5E	uppermost Castlegate	16	N	340	-20	375	
600-137	ne sw	22	21S	5E	uppermost Castlegate	36	N	340	-20	225	
600-137	ne sw	22	21S	5E	uppermost Castlegate	37	N	340	-20	150	
600-137	ne sw	22	21S	5E	uppermost Castlegate	38	N	340	-20	200	
600-138	w 1/2	15	21S	5E	uppermost Castlegate	32	N	340	-20	200	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	50	N	340	-20	200	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	51	N	340	-20	175	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	52	N	340	-20	125	30
600-138	se 1/4	15	21S	5E	uppermost Castlegate	53	N	340	-20	175	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	57	N	340	-20	150	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	58	N	340	-20	200	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	59	N	340	-20	225	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate	22	N	340	-20	150	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate	23	N	340	-20	175	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate	24	N	340	-20	100	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate	25	N	340	-20	150	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate	26	N	340	-20	100	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate	27	N	340	-20	125	
100-38	nw se	33	20S	5E	uppermost Castlegate	9	N	340	-20	225	40
100-38	nw se	33	20S	5E	uppermost Castlegate	10	N	340	-20	250	
100-38	e 1/2	33	20S	5E	uppermost Castlegate	26	N	340	-20	150	
100-38	e 1/2	33	20S	5E	uppermost Castlegate	27	N	340	-20	150	
100-38	e 1/2	33	20S	5E	uppermost Castlegate	28	N	340	-20	200	
100-42	w1/2 sw	20	21S	5E	uppermost Castlegate	1	N	341	-19	300	
100-42	se nw	20	21S	5E	uppermost Castlegate	11	N	341	-19	200	
100-42	se nw	20	21S	5E	uppermost Castlegate	19	N	341	-19	150	
100-42	se nw	20	21S	5E	uppermost Castlegate	23	N	341	-19	150	
100-42	sw se	21	21S	5E	uppermost Castlegate	37	N	341	-19	500	
200-185	e 1/2	11	21S	5E	uppermost Castlegate	12	N	341	-19	200	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	6	N	341	-19	100	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	16	N	341	-19	125	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	17	N	341	-19	125	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	18	N	341	-19	175	
600-138	w 1/2	15	21S	5E	uppermost Castlegate	41	N	341	-19	125	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	47	N	341	-19	200	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	48	N	341	-19	175	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	49	N	341	-19	100	
600-138	se 1/4	15	21S	5E	uppermost Castlegate	54	N	341	-19	175	

Greens Hollow Tract Air Photo Fracture Pattern Analysis										360		
Tract + Buffer, North-Trending Quadrant Fracture Data Values												
Air Photo ID	**Area Designation** (Public Land Survey System, Salt Lake Base and Meridian)				**Stratigraphic Unit**		**Fracture Analysis** Air Photo scale is 1:17500 (9 measures) * Use Engineer's 30 scale (1" = 1500', with smallest division = 50')					Assume
Line - Photo ID	1/4 1/4	Section	Township	Range	all uppermost Castlegate		ID #	Quadrant (N=315-45 E=45-135)	Orientation (0 - 359)	Orientation (-45 to +45)	Length* (ft)	Spacing* (ft)
600-138	se 1/4	15	21S	5E	uppermost Castlegate		55	N	341	-19	150	
600-138	se 1/4	15	21S	5E	uppermost Castlegate		56	N	341	-19	175	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate		19	N	341	-19	125	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate		20	N	341	-19	225	
600-138	sw 1/4	10	21S	5E	uppermost Castlegate		21	N	341	-19	200	
600-139	w 1/2	3	21S	5E	uppermost Castlegate		3	N	341	-19	250	
600-139	w 1/2	3	21S	5E	uppermost Castlegate		4	N	341	-19	300	
600-139	w 1/2	3	21S	5E	uppermost Castlegate		5	N	341	-19	250	
600-139	w 1/2	3	21S	5E	uppermost Castlegate		8	N	341	-19	250	
600-139	w 1/2	3	21S	5E	uppermost Castlegate		9	N	341	-19	150	
100-38	se nw	33	20S	5E	uppermost Castlegate		7	N	341	-19	325	50
100-38	se nw	33	20S	5E	uppermost Castlegate		8	N	341	-19	200	
100-38	e 1/2	33	20S	5E	uppermost Castlegate		29	N	341	-19	200	
100-42	se nw	20	21S	5E	uppermost Castlegate		17	N	342	-18	125	50
100-42	se nw	20	21S	5E	uppermost Castlegate		18	N	342	-18	100	
100-42	se nw	20	21S	5E	uppermost Castlegate		20	N	342	-18	125	
100-42	se nw	20	21S	5E	uppermost Castlegate		24	N	342	-18	100	40
100-42	se nw	20	21S	5E	uppermost Castlegate		25	N	342	-18	100	
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		13	N	342	-18	225	50
200-184	ne 1/4	11	21S	5E	uppermost Castlegate		14	N	342	-18	275	
200-185	e 1/2	11	21S	5E	uppermost Castlegate		11	N	342	-18	300	
200-185	e 1/2	11	21S	5E	uppermost Castlegate		15	N	342	-18	325	
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate		13	N	342	-18	300	
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate		14	N	342	-18	175	60
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate		15	N	342	-18	200	
600-137	ne 1/4	22	21S	5E	uppermost Castlegate		11	N	342	-18	350	
600-137	ne 1/4	22	21S	5E	uppermost Castlegate		20	N	342	-18	200	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate		2	N	342	-18	175	30
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate		3	N	342	-18	125	40
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate		4	N	342	-18	200	30
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate		5	N	342	-18	175	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate		14	N	342	-18	100	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate		15	N	342	-18	225	
600-138	w 1/2	15	21S	5E	uppermost Castlegate		37	N	342	-18	150	50
600-138	w 1/2	15	21S	5E	uppermost Castlegate		38	N	342	-18	200	
600-138	w 1/2	15	21S	5E	uppermost Castlegate		39	N	342	-18	150	
600-138	w 1/2	15	21S	5E	uppermost Castlegate		40	N	342	-18	150	
100-38	nw nw	33	20S	5E	uppermost Castlegate		1	N	342	-18	150	
100-38	nw nw	33	20S	5E	uppermost Castlegate		2	N	342	-18	225	
100-38	nw nw	33	20S	5E	uppermost Castlegate		3	N	342	-18	375	
100-38	nw nw	33	20S	5E	uppermost Castlegate		4	N	342	-18	150	
100-38	nw nw	33	20S	5E	uppermost Castlegate		5	N	342	-18	175	
200-45	s 1/2	19	21S	5E	uppermost Castlegate		19	N	343	-17	75	30

Greens Hollow Tract Air Photo Fracture Pattern Analysis										360		
Tract + Buffer, North-Trending Quadrant Fracture Data Values												
Air Photo ID	**Area Designation** (Public Land Survey System, Salt Lake Base and Meridian)				**Stratigraphic Unit**	**Fracture Analysis** Air Photo scale is 1:17500 (9 measures) * Use Engineer's 30 scale (1" = 1500', with smallest division = 50')						Assume
Line - Photo ID	1/4 1/4	Section	Township	Range	all uppermost Castlegate	ID #	Quadrant (N=315-45 E=45-135)	Orientation (0 - 359)	Orientation (-45 to +45)	Length* (ft)	Spacing* (ft)	
200-45	s 1/2	19	21S	5E	uppermost Castlegate	20	N	343	-17	75		
200-45	s 1/2	19	21S	5E	uppermost Castlegate	21	N	343	-17	225	40	
200-45	s 1/2	19	21S	5E	uppermost Castlegate	22	N	343	-17	100		
200-45	s 1/2	19	21S	5E	uppermost Castlegate	23	N	343	-17	100		
600-137	se 1/4	15	21S	5E	uppermost Castlegate	5	N	343	-17	200		
600-137	se 1/4	15	21S	5E	uppermost Castlegate	9	N	343	-17	200		
600-137	se 1/4	15	21S	5E	uppermost Castlegate	10	N	343	-17	350		
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	10	N	343	-17	100		
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	11	N	343	-17	275		
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	12	N	343	-17	650		
600-138	w 1/2	15	21S	5E	uppermost Castlegate	42	N	343	-17	225		
600-138	w 1/2	15	21S	5E	uppermost Castlegate	43	N	343	-17	150	30	
600-138	w 1/2	15	21S	5E	uppermost Castlegate	44	N	343	-17	125		
600-138	w 1/2	15	21S	5E	uppermost Castlegate	45	N	343	-17	150		
600-138	w 1/2	15	21S	5E	uppermost Castlegate	46	N	343	-17	200		
100-38	e 1/2	33	20S	5E	uppermost Castlegate	18	N	343	-17	275	40	
100-38	e 1/2	33	20S	5E	uppermost Castlegate	19	N	343	-17	300		
100-36	se sw	21	20S	5E	uppermost Castlegate	9	N	344	-16	100		
100-42	se nw	20	21S	5E	uppermost Castlegate	7	N	344	-16	725		
100-42	se nw	20	21S	5E	uppermost Castlegate	8	N	344	-16	350		
200-45	s 1/2	19	21S	5E	uppermost Castlegate	17	N	344	-16	175		
200-45	s 1/2	19	21S	5E	uppermost Castlegate	18	N	344	-16	300		
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	7	N	344	-16	125	30	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	8	N	344	-16	125		
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate	9	N	344	-16	100		
600-138	w 1/2	15	21S	5E	uppermost Castlegate	33	N	344	-16	275		
600-138	w 1/2	15	21S	5E	uppermost Castlegate	34	N	344	-16	500	60	
600-138	w 1/2	15	21S	5E	uppermost Castlegate	35	N	344	-16	200		
600-138	w 1/2	15	21S	5E	uppermost Castlegate	36	N	344	-16	150		
100-38	e 1/2	33	20S	5E	uppermost Castlegate	17	N	344	-16	175		
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate	12	N	345	-15	300		
200-45	s 1/2	19	21S	5E	uppermost Castlegate	24	N	345	-15	100		
200-45	s 1/2	19	21S	5E	uppermost Castlegate	26	N	345	-15	125		
200-45	s 1/2	19	21S	5E	uppermost Castlegate	27	N	345	-15	75		
200-45	s 1/2	19	21S	5E	uppermost Castlegate	28	N	345	-15	125		
600-139	w 1/2	3	21S	5E	uppermost Castlegate	1	N	345	-15	200		
600-139	w 1/2	3	21S	5E	uppermost Castlegate	6	N	345	-15	300		
600-139	w 1/2	3	21S	5E	uppermost Castlegate	7	N	345	-15	100		
100-38	e 1/2	33	20S	5E	uppermost Castlegate	13	N	345	-15	225		
100-38	e 1/2	33	20S	5E	uppermost Castlegate	14	N	345	-15	100		
100-38	e 1/2	33	20S	5E	uppermost Castlegate	15	N	345	-15	150		
100-38	e 1/2	33	20S	5E	uppermost Castlegate	16	N	345	-15	200		
100-38	e 1/2	33	20S	5E	uppermost Castlegate	21	N	345	-15	250		

Greens Hollow Tract Air Photo Fracture Pattern Analysis										360		
Tract + Buffer, North-Trending Quadrant Fracture Data Values												
Air Photo ID	**Area Designation** (Public Land Survey System, Salt Lake Base and Meridian)				**Stratigraphic Unit**		**Fracture Analysis** Air Photo scale is 1:17500 (9 measures) * Use Engineer's 30 scale (1" = 1500', with smallest division = 50')					Assume
Line - Photo ID	1/4 1/4	Section	Township	Range	all uppermost Castlegate		ID #	Quadrant (N=315-45 E=45-135)	Orientation (0 - 359)	Orientation (-45 to +45)	Length* (ft)	Spacing* (ft)
200-45	s 1/2	19	21S	5E	uppermost Castlegate		25	N	346	-14	150	
600-138	w1/2 ne	10	21S	5E	uppermost Castlegate		1	N	346	-14	150	
100-36	se sw	21	20S	5E	uppermost Castlegate		11	N	347	-13	175	40
100-36	se sw	21	20S	5E	uppermost Castlegate		12	N	347	-13	250	
100-36	se sw	21	20S	5E	uppermost Castlegate		13	N	347	-13	225	
100-36	se sw	21	20S	5E	uppermost Castlegate		14	N	347	-13	225	40
100-36	se sw	21	20S	5E	uppermost Castlegate		15	N	347	-13	150	30
100-36	se sw	21	20S	5E	uppermost Castlegate		16	N	347	-13	125	
200-45	se 1/4	18	21S	5E	uppermost Castlegate		3	N	347	-13	75	
100-42	sw se	21	21S	5E	uppermost Castlegate		33	N	348	-12	400	
200-45	se 1/4	18	21S	5E	uppermost Castlegate		2	N	348	-12	400	
200-45	se 1/4	18	21S	5E	uppermost Castlegate		4	N	348	-12	75	50
200-45	se 1/4	18	21S	5E	uppermost Castlegate		5	N	348	-12	200	
200-45	se 1/4	18	21S	5E	uppermost Castlegate		6	N	348	-12	250	
200-45	se 1/4	18	21S	5E	uppermost Castlegate		7	N	348	-12	125	
100-38	e 1/2	33	20S	5E	uppermost Castlegate		32	N	349	-11	100	40
100-38	e 1/2	33	20S	5E	uppermost Castlegate		33	N	349	-11	75	
200-45	e1/2 ne	19	21S	5E	uppermost Castlegate		8	N	350	-10	150	
200-45	se 1/4	18	21S	5E	uppermost Castlegate		1	N	355	-5	125	
Statistics:												
Count									**278**	**278**	**278**	**44**
Maximum		**maximum value in the distribution**							**355**	**-5**	**725**	**60**
Minimum		**minimum value in the distribution**							**0**	**-360**	**75**	**30**
Average		**mean of the distribution**							**---**	**-24**	**207**	**42**
St. Dev.		**standard deviation of the distribution**							**---**	**35**	**103**	**10**
Median		**the value in the middle of the distribution**							**---**	**-20**	**200**	**40**
Mode		**the most frequent occurring or repetitive value of the distribution**							**---**	**-20**	**200**	**40**

THE ENTIRE TEXT FOR EACH CHAPTER IS INCLUDED IN THIS SUBMITTAL FOR EASE OF REVIEW.

ONCE APPROVED ONLY PAGES WITH CHANGES WILL BE SUBMITTED.

CHAPTER 7

HYDROLOGY

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CHAPTER 7

HYDROLOGY

7.10 Introduction

7.1.1 General Requirements

This chapter presents a description of:

- existing hydrologic resources within the permit and adjacent areas;
- proposed operations and the potential impacts to the hydrologic balance;
- methods of compliance with design criteria;
- applicable hydrologic performance standards; and
- hydrologic reclamation plans for the SUFCO Mine.

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

7.1.2 Certification

All maps, plans, and cross sections presented in this chapter have been certified by a qualified, registered professional engineer.

7.1.3 Inspection

Impoundments associated with the mining and reclamation operations will be inspected as described in Section 5.1.4.3 of this M&RP.

7.20 Environmental Description

7.2.1 General Requirements

This section presents a description of the premining hydrologic resources within the permit area and adjacent areas that may be affected or impacted by the proposed coal mining and reclamation operation.

7.2.2 Cross Sections and Maps

7.2.2.1 Location and Extent of Subsurface Water

Groundwater occurs in perched zones of limited areal extent within the lease area. The PHC studies conducted by Mayo and Associates (Appendix 7-17 and Appendix 7-18) have determined that none of the formations down through the Blackhawk support a continuous aquifer. According to Mayo's research all of the aquifers within the permit area and adjacent areas are perched and discontinuous so it is not possible to represent a potentiometric surface for the area.

Seasonal variations in well water levels are discussed in Section 7.2.4.1.

7.2.2.2 Location of Surface Water Bodies

A map showing the location of surface water bodies (such as streams, ponds, and springs) for which water rights exist or for which there are pending water rights applications is provided as Plate 7-2. A listing of water rights data (names, locations and ownership) is presented in Appendix 7-1. Other than for the indicated springs, no water rights exist for groundwater in the permit and adjacent areas.

7.2.2.3 Locations of Monitoring Stations

Surface water and groundwater monitoring stations associated with the SUFCO operation are located as shown on Plate 7-3. Approximate surface elevations of the monitoring stations are also indicated on Plate 7-3.

7.2.2.4 Location and Depth of Water Wells

No water-supply wells exist in the permit or adjacent areas. Groundwater monitoring wells in the area are located as shown on Plate 7-3. Depths of these wells and other completion details are summarized in Table 7-1.

7.2.2.5 Surface Topography

Surface topographic features in the permit and adjacent areas are shown on the base maps used for Plate 7-3.

7.2.3 Sampling and Analysis

All water samples collected for use in this M&RP 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.

7.2.4 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.

7.2.4.1 Groundwater Information

This section presents a discussion of baseline groundwater conditions in the mine area. A discussion of the groundwater conditions in the SUFCO lease area is presented in this section and appended by Appendix 7-17. A discussion of groundwater conditions in the Pines Tract is presented in Appendix 7-18 of this Chapter. A discussion of groundwater conditions in the West Coal Lease Modifications is presented in Appendix 7-24 of this Chapter. A discussion of groundwater conditions at the waste rock disposal site is provided in ~~Volume 3~~ Waste Rock Volume of this M&RP.

The locations of wells and springs in the mine area are presented on Plate 7-3. The wells in the mine area are all water monitoring wells, not water supply wells. Water rights for the mine and

(Table 7-1)

Observation Well Completion Summary

adjacent areas are addressed in Section 7.2.2.2 of this M&RP. With the exception of the potable use of source 94-87 by SUFCO, all other groundwater use (seeps and springs) is confined to stock watering. Appendix 7-27 contains water monitoring data for the Green Hollow Tract.

AQUIFERS

Geologic conditions in the permit and adjacent areas are described in detail in Chapter 6 of this M&RP. Groundwater occurrences within the permit and adjacent areas occurs predominantly in the Blackhawk Formation and Star Point Sandstone. However, perched aquifers of limited areal extent are present in the geologic formations. Hydrogeologic conditions within the permit and adjacent areas are summarized below.

North Horn Formation. The North Horn Formation crops out in the northwest portion of the lease area. This formation consists of interbedded shale, sandstone, and limestone. Data presented in Appendix 7-2 indicate that only one seep and one spring issue from the North Horn Formation within the lease area. Recharge occurs to outcrops of the North Horn Formation west of the lease area (Thiros and Cordy, 1991). Thus, it may serve as an aquifer in some portions of the western adjacent area.

Upper Price River Formation. The upper Price River Formation consists of about 450 feet of interbedded sandstone and claystone. Within the lease area, the upper Price River Formation has not been identified as a significant aquifer. Thiros and Cordy (1991) estimated that combined recharge to the upper Price River Formation and the Castlegate Sandstone is limited to 1.2 percent of the total annual precipitation. As indicated in Appendix 7-2, a few isolated springs have been identified discharging from the sandstone lenses within the formation. No groundwater has been identified within this formation during the exploration drilling which has been conducted from the top of the plateau. As a result no monitoring or water supply wells have been completed in this formation within the mining area.

Five monitoring wells have been completed in a massive sandstone unit in the Price River Formation at the waste rock disposal site. Hydrographs of three representative wells (B-3, B-6, and B-8) are depicted in Figure 7-1. Seasonal fluctuations are typically less than one foot in wells B-3 and B-6, and less than three feet in B-8. All three wells display a general downward trend in water levels from spring to late summer (see also Appendix 7-4 and Waste Rock Volume 3).

Castlegate Sandstone. The Castlegate Sandstone consists of an estimated 120 to 260 feet of medium to coarse-grained sandstone with a few thin interbedded mudstones or shales near the base. The sandstone is conglomeratic, forms prominent cliffs along the outcrop, and is well cemented with calcarious cement.

A limited number of springs issue from the Castlegate Sandstone in the Quitchupah lease area, with flow generally less than 1 gpm. In the Pines Tract area, several springs issue from and near the base of the Castlegate Sandstone. The waters from these springs feed the Main Fork and East Fork of Box Canyon Creek. Base flow from these springs is generally less than 1 to 2 gpm with a few flowing at rates of 5 to 6 gpm.

Based on information from the exploration drill holes and observation wells in the lease area, the Castlegate Sandstone contains small quantities of groundwater. No significant quantities of groundwater (more than 2 gpm) were encountered in any of the exploration holes nor was groundwater identified in all drill holes.

Of the observation wells completed in the Castlegate Sandstone in the lease area, two (US-77-9 and 89-16-1W) have been dry during their entire period of record. Two additional wells (US-77-8 and 89-20-2W) have only a brief period of record (due to lack of water or time since installation, respectively). Hydrographs of the remaining two Castlegate Sandstone observation wells (US-80-2 and US-80-4) are presented in Figure 7-2. Water-level data for all wells are provided in Appendix 7-3. Seasonal fluctuations of groundwater levels in these wells have typically been less than one foot.

(Figure 7-1)

Upper Price River Formation Hydrographs

Coal exploration holes drilled in and near the Pines Tract by the USGS, have geophysical logs indicating similar conditions for the Castlegate Sandstone. Exploration Hole W-TP-4-EW found fluids present at a depth of 82 feet below ground surface, within the Castlegate Sandstone. Exploration holes W-TP-3-EW and W-TP-2-EW did not encounter fluids within the Castlegate Sandstone.

This formation is not considered to be a significant regional aquifer. It is assumed that the groundwater occurrence within the Castlegate Sandstone is limited to isolated perched zones contained in the more permeable sandstone lenses or within weathered bedrock and fractures/joints at and near the escarpments within Box Canyon. Because groundwater occurrence within the Castlegate Sandstone is not continuous over the permit and adjacent areas, no potentiometric surface could be developed for the unit.

The data presented in Figure 7-2 indicate a downward trend in static water levels for the Castlegate Sandstone. This trend is most probably due to decreased precipitation during the last several years. A discussion of climatic conditions in the permit and adjacent areas is provided in Section 7.2.4.4 of this M&RP.

Groundwater recharge to the Castlegate Sandstone is from precipitation and snowmelt. Over much of the lease area, the Castlegate Sandstone and the remainder of the Price River Formation form the surface of the plateau. However, as evidenced by the fact that the Castlegate is not continuously saturated, total recharge is probably low. This is due to the lack of a significant developed soil to encourage infiltration and the presence of low permeability shales in the upper Price River Formation (see Waddell et al., 1979).

Discharge from the Castlegate Sandstone occurs mainly as springs along the outcrop and as through-flow to the underlying Blackhawk Formation. As indicated above, spring flow from the unit is limited in flow and in occurrence. These springs are used only for livestock and wildlife watering. Besides the monitoring wells completed in the Castlegate Sandstone, no known wells are completed in the formation.

Blackhawk Formation. The Blackhawk Formation underlies the Castlegate Sandstone and consists of about 710 to 830 feet of interbedded sandstone, siltstone, shale, and coal. The Upper Hiawatha coal seam, mined by SUFCO, is located near the base of the Blackhawk Formation. During the drilling of the exploration and observation holes, groundwater was encountered in each of the drill holes; however, no significant quantities of water were identified in any of the holes.

Recharge to the Blackhawk Formation occurs mainly from vertical movement of water from the overlying Castlegate Sandstone. Recharge from direct infiltration where the Blackhawk Formation is exposed is considered to be negligible due to the limited area of exposure. The quantity of groundwater recharge in the region area has been estimated to be 3 to 8 percent of the average annual precipitation (Danielson and Sylla, 1983).

Discharge from the Blackhawk Formation occurs from springs, seeps, and the SUFCO Mine. Based on both the drilling and underground observations, groundwater flow in the Blackhawk Formation appears to occur primarily along fractures. Few springs or seeps are present in the Blackhawk sandstone lens outcrop areas. This suggests that general flow through the pores in the sandstone is not significant.

Generally, flow rates from the springs and seeps issuing from the Blackhawk Formation are moderate to low in the spring and decline through the summer and into the fall (Appendix 7-1). These flow rates are typically less than 1 gpm with a few flowing at a slightly higher rate in the Pines Tract area.

At the SUFCO mine, groundwater is encountered in the underground workings. Since 1982, the mine has discharged at an average flow rate of 580 gpm (1.29 cfs). The underground water is primarily encountered at the working faces and is associated with faults, fractures, and roof bolt holes. As with many of the mines in the Wasatch Plateau, these zones yield water readily when new areas are opened, but inflow rates normally decrease rapidly as mining progresses. The inflow rates are commonly less than 5 gpm at any given point and cease after a few months, suggesting

(Figure 7-2)

Castlegate Sandstone Hydrographs

the presence of perched aquifers of limited areal extent. Monitoring point SUFCO-062, which has been the only underground monitoring point for inflow, averages 0.0011 cfs (0.49 gpm).

Hydrographs of water levels in selected Blackhawk Formation observation wells are presented in Figure 7-3. As indicated in these hydrographs and the remaining data provided in Appendices 7-3, seasonal water-level fluctuations are typically less than two feet. However, the long-term trend is for water-level elevations to be decreasing.

The downward trend in water-level elevations is probably caused by two factors. First, decreased precipitation during the past few years (see Section 7.2.4.4 of this M&RP) has contributed to lower groundwater recharge in the area. Second, interception of groundwater by mining operations has increased groundwater discharge from the area.

Star Point Sandstone. The Star Point Sandstone is fine to medium grained in texture with the coarser grained material occurring in the upper portions of the formation. The Star Point forms a well defined cliff between the slopes of the Mancos Shale and the overlying Blackhawk Formation. Except where eroded or exposed in deep canyons, the Star Point Sandstone underlies the entire lease area.

In 1989, four monitoring wells were completed in the basal Blackhawk/upper Star Point Formation. The wells ranged from 1012 to 1300 feet deep and were completed in the intervals indicated on Table 7-1. These holes did not encounter significant quantities of groundwater.

Recharge to the Star Point Sandstone probably occurs primarily from vertical movement of the water through the overlying Blackhawk Formation. Discharge from the Star Point is considered to be primarily to adjacent canyons at the contact with the underlying Mancos Shale. These discharge points are generally covered with alluvial fill of the stream systems. Therefore, little surface expression of the discharge has been identified.

Mancos Shale. Underlying the entire mine lease area and exposed in the deep canyons is the Mancos Shale. This dark, slope-forming, marine shale is relatively impermeable and is not considered to be a regional or local aquifer (Danielson and Sylla, 1983).

Quaternary Alluvium. Unconsolidated Quaternary deposits are present along streams and generally consist of silts, sands, and occasional gravels. The deposits, which have low to moderate permeability, receive water from the adjacent bedrock in some of the deeply incised canyons. Discharge from these materials is to the surface water system. SUFCO collects water in the alluvium at the base of East Spring Canyon and pumps it to the mine for use as culinary water. The average flow from this source is approximately 25 gpm. Water is probably supplied to the alluvium by seepage from the Blackhawk Formation and Star Point Sandstone.

RECHARGE

Recharge within the lease area occurs primarily on the exposed upland outcrops of the Price River Formation and the Castlegate Sandstone. The annual recharge to these units is estimated to be 1.2 percent of the total annual precipitation. "Much recharge occurs" on outcrops of the Flagstaff Limestone and the North Horn Formation west of the lease area (Thiros and Cordy, 1991). Recharge to the Blackhawk Formation and the Star Point Sandstone probably occurs primarily from vertical movement of water through the overlying formations. The Mancos Formation underlies the entire area and is exposed in the deep canyons. It is relatively impermeable. Groundwater descending from the Star Point Sandstone flows along the Mancos-Star Point contact and discharges to the surface.

Locally, recharge is probably greater where surface fractures intersect topographic highs (plateaus). These areas occur where the North Horn Formation or the Castlegate Sandstone crops out (Thiros and Cordy, 1991). The North Horn Formation crops out in the northwest corner and along the western border of the lease area. The Castlegate Sandstone generally crops out along the top edges of the steep-walled canyons (Plate 6-1). However, in the east and north central parts of the permit area, the Castlegate Sandstone caps the plateaus in relatively large areas. According to Thiros and Cordy (1991), recharge is increased where fractures extend down through the Price

(Figure 7-3)

Blackhawk Formation Hydrographs

River Formation to the Castlegate Sandstone. This may occur in the southwestern corner of the permit area where subsidence cracks have been seen to penetrate the Castlegate Sandstone and Price River Formation (Thiros and Cordy, 1991). Additionally, faults along the western and northern margins of the permit area may increase secondary permeability, thus locally increasing recharge.

Recharge occurs in the northwest corner (T.21 S., R.4 E., sections 11 and 23) and the northeastern part of the permit area (T.21 S., R.5 E., section 16). The first area is a topographic high and fractured where the North Horn Formation crops out. The second area is a topographic high, capped by the Price River Formation. Linear features that imply fracturing are located in this area (Plate 6-1 and SUFCO, 1992).

Recharge to shallowly circulating groundwater systems within the Castlegate Sandstone and Blackhawk Formation also occurs in the Pines Tract area. These shallow groundwater systems appear to occur within approximately 1000 feet of the Box Canyon escarpments.

The recharge age for water flowing into the SUFCO mine was estimated at 70 years or older (Thiros and Cordy, 1991). Mayo and Associates (1997a and 1997b) identified mean groundwater residence times for in-mine discharges of 7,000 to 20,000 years. This indicates that recharge to the Blackhawk aquifer is not being affected by the increased hydraulic conductivities created by subsidence.

Assuming mass-balance and stable hydrologic conditions in the permit area, over the long term, recharge must be equal to discharge. Recharge occurs mostly on the plateaus and over time moves vertically downward primarily along fractures. Where perched aquifers are encountered, the groundwater may flow through the aquifer until it meets an impermeable layer. Vertical flow typically does not extend below the top of the Mancos Formation.

Greens Hollow Tract

In 2015 and 2016 samples were collected as close as possible to the Greens Hollow Tract to be analyzed for age and one sample was analyzed for water chemistry. Three locations were sampled, two samples were close together thus the drawing has one arrow designating both locations. The recharge age for the waters sampled is similar to conclusions previously in this section. Refer to Appendix 7-27 for copies of the analyses and a drawing showing the sample locations.

Pre-Mine head in the coal has been measured in four observation wells completed in the Upper Hiawatha coal seam in the vicinity of Duncan Mountain. The three wells near the edge of the Wasatch Plateau were found to be dry. The head in the mine following cessation of mining and pumping would be expected to recover to approximately 80 percent of the premining level. Based on this assumption the heads in the mined-out area of the Greens Hollow tract would be expected to remain below the elevation at the outcrop of the Hiawatha coal seam near the edge of the Wasatch Plateau. Pressure redistribution with the coal supports rapid recovery of about 80 percent of the potentiometric levels to pre-mining levels. The final 20 percent of recovery occurs more slowly. Most of the water entering the coal during final recovery is stored within units of the Blackhawk Formation. Any effects on the ground water discharges from the underlying Star Point Sandstone or the hydrogeologic units located stratigraphically above the coal would be low and unmeasurable. (Cirrus, (2013c).

According to the FSEIS "water conveying faults are not expected to be encountered during underground mining in the Greens Hollow Tract". Anderson (2004a) found faulting in the study area to be minimal.

WATER QUALITY

Observation wells and springs that are monitored as part of the SUFCO hydrologic monitoring program are monitored three times per year. Due to the general inaccessibility of the sample points during the winter, no winter sampling occurs. A historical summary of water-quality analyses for groundwater samples (wells, springs and mine inflow) collected from the permit and adjacent areas is presented in Appendix 7-4.

Groundwater-quality samples have been collected in the permit and adjacent areas from:

- Springs that issue from the North Horn Formation, the upper Price River Formation, the Castlegate Sandstone, the Blackhawk Formation, and the Star Point Sandstone,

- Monitoring wells at the waste-rock disposal site that are completed in the upper Price River Formation, and

- Mine inflow that issues from the Blackhawk Formation.

Results of analyses of these samples have been submitted to UDOGM. Historical results are summarized in Appendix 7-4.

Historical data have been collected from one spring issuing from the North Horn Formation (SUFCO-057A). Over its period of record, the water issuing from this spring has been a calcium bicarbonate type with an average total dissolved solids (TDS) concentration of 371 mg/l and an average pH of 7.5. Total and dissolved iron concentrations have averaged 0.24 and 0.02 mg/l, respectively. Total manganese concentrations have averaged 0.09 mg/l. Except for one apparent outlier, dissolved manganese concentrations at the spring have averaged 0.04 mg/l. Insufficient data are available to determine seasonal trends in water quality from this spring.

One spring and three monitoring wells completed in the upper Price River Formation have been sampled in the permit and adjacent areas. Historical data collected from the spring (GW-13) indicates that this water is a sodium bicarbonate type with an average TDS concentration of 745 mg/l and an average pH of 7.3. Dissolved iron and dissolved manganese concentrations have averaged 0.08 and 0.05, respectively, during the period of record. Data concerning total iron and total manganese are not available. The limited data suggest that pH and TDS concentrations are inversely proportional to flow while iron and manganese concentrations are directly proportional to flow. However, the data base is currently insufficient (seven sampling events) to draw detailed conclusions.

Historical data collected from the monitoring wells (located at the waste-rock disposal site) indicate that the water in this area is of mixed chemical type with no consistently dominant ions. TDS concentrations in groundwater immediately underlying the waste-rock disposal site are high relative to other portions of the permit area (average TDS concentration of 2100 to 6170 mg/l), with average pH values that are approximately neutral (varying between the wells from 6.8 to 7.2). Dissolved iron and dissolved manganese concentrations have averaged 0.1 mg/l or less at the three wells (with the exception of one apparent outlier manganese value). Data concerning total iron and total manganese are not available. Although there are no historic seasonal trends in the available data, the water quality data show that in 1991, sulfate and bicarbonate concentrations increased and chloride concentrations and pH values decreased from spring to fall (Appendix 7-4 and Waste Rock Volume~~3~~).

TDS concentrations generally increase in the downgradient direction beneath the waste-rock disposal site. This increase is natural as evidenced by data collected prior to the onset of waste-disposal operations. The relatively high TDS concentrations at the site (compared, for example, with spring GW-13) and the downgradient increases in these concentrations are considered to be the result of natural dissolution of minerals in the general vicinity of the site.

Three springs issuing from the Castlegate Sandstone (SUFCO-001, SUFCO-089, and GW-21) were sampled as part of the SUFCO hydrologic monitoring program. All water issuing from these springs is a calcium bicarbonate type, with historic mean TDS concentrations varying from 82 to 302 mg/l. The average TDS concentration between all three springs was 238 mg/l.

Spring waters issuing from the Castlegate Sandstone and Blackhawk Formation in the Pines Tract area are also calcium bicarbonate type. Historic TDS concentrations vary from 90 to 450 mg/l. Additional information regarding the physical and chemical characteristics of the springs in the Pines Tract is contained in Appendix 7-18 in the Probable Hydrologic Consequences of Mining in the Pines Tract Area, SUFCO Mine.

The pH of water issuing from the Castlegate Sandstone springs is approximately neutral. Dissolved iron and dissolved manganese historically averaged 0.03 and 0.01 mg/l, respectively, at SUFCO-001 and GW-21. At SUFCO-089, dissolved iron and dissolved manganese averaged 0.47 and 0.17 mg/l, respectively. At SUFCO-001, total iron and total manganese concentrations historically averaged 0.11 and 0.01 mg/l, respectively. None of the chemical data have exhibited consistent seasonal trends.

Historical data collected from stations SUFCO-047 and SUFCO-062 are considered representative of the Blackhawk-Star Point aquifer. Although station SUFCO-047 consists of seepage collected from alluvium and used for the mine domestic water supply, it is regarded as being fed by outflow from the adjacent Blackhawk-Star Point aquifer. Station SUFCO-062 represents inflow to the mine from the surrounding Blackhawk Formation.

Groundwater from these two sources is a calcium bicarbonate type, with historical TDS concentrations averaging 373 to 492 mg/l and pH values averaging 7.2 to 7.5. Between the two sources, average total iron concentrations range from 0.08 to 0.15 mg/l while average dissolved iron concentrations are both equal to 0.02 mg/l. Total manganese concentrations average 0.05 to 0.06 mg/l between the two sources, while dissolved manganese concentrations average 0.02 to 0.05 mg/l. The data have not exhibited consistent seasonal trends.

As a general point of comparison, the ground water quality analyses were compared to the primary drinking water standards (40 CFR 141) and the secondary drinking water standards (40 CFR 143).

These comparisons indicate that there were no exceedances of the primary drinking water standards for any of the groundwater samples. Exceedances of the secondary drinking water standards were found in groundwater samples only for sulfate and TDS concentrations (with recommended standards of 250 mg/l and 500 mg/l, respectively). All of the sulfate exceedances and most of the TDS exceedances occurred in groundwater collected from monitoring wells at the waste-rock disposal site. These exceedances are probably due to the natural dissolution of marine salts known to exist in the local strata (Waddell et al., 1981).

Greens Hollow Tract

The description is based on and extensive three year study of the Muddy Creek area and a 2-mile buffer surrounding the tract performed by Cirrus in 2004 and the continuation of sampling by the Permittee. Springs were identified as occurring in the Castlegate, Price River and North Horn formations. "The overall risk for permanent water loss at any spring located within the tract sould be relatively low" (FSEIS, 2015).

Cirrus- A total of 33 springs were measured for flow and various parameters during the spring and fall seasons for 2001 to 2004. A summary of the collected data in included in the tables of the Surface and Groundwater Report located in Appendix 7-27. Water quality samples were collected for laboratory analysis from eight springs during 2001 - 2004. The field parameter monitoring results for the springs indicate that the relevant criteria for the State of Utah with the exception of dissolved oxygen, which is typically low in springs. Laboratory analysis met the relevant criteria except for some slight exceedances in arsenic, cadmium, lead, TDS, selenium and zinc. Based on the knowledge of local geology and soil the water chemistry reflects natural conditions.

The permittee continued monitoring selected springs and surface water locations shown on Plate 7-3 and the data is summarized in Appendix 7-27. Summaries include data spring data for M-SP 4, 5, 6, 9, 15, 19, 20, 40, 41, 44, 45, 60, 82,87, 100, 103, 104, 105, 106, and 260

7.2.4.2 Surface Water Information

<u>WATER QUANTITY</u>

Major surface drainages in the permit and adjacent areas are depicted in Figure 7-4. As indicated, the lease area exists entirely within the Muddy Creek watershed. Most of the lease area drains southward into Quitchupah Creek via the North Fork of Quitchupah Creek and various ephemeral tributaries. Quitchupah Creek flows southeastward into Ivie Creek which in turn flows eastward into Muddy Creek. The northeast portion of the lease area, including the majority of the Pines Tract, drains into Muddy Creek via Box Canyon.

Based on flow data obtained during the collection of water-quality samples, the following streams are considered perennial within the lease area:

- North Fork of Quitchupah Creek (as measured at stations SUFCO-007 and SUFCO-042)
- South Fork of the North Fork of Quitchupah Creek (as measured at station SUFCO-006)
- Quitchupah Creek (as measured at stations SUFCO-041 and SUFCO-046)
- Box Canyon, including East Fork Box Canyon (as measured at stations SUFCO-090, Pines 403, Pines 407 and Pines 408)
- Muddy Creek (as measured at stations Pines 405 and Pines 406)
- Cowboy Creek (as measured at station M-STR4)

According to Thiros and Cordy (1991), Link Canyon contains an ephemeral stream. Two small areas of riparian vegetation are supported in the canyon by discharge from springs near the head of the canyon (Link Canyon Spring GW-21, Plate 7-3) and the abandoned Link Canyon Mine workings (Link Portal West and Link Portal East, Plate 7-3). Water from Spring GW-21 near the head of Link Canyon typically flows only about 300 to 750 feet below the source, depending upon the season. Water discharged from the Link Canyon portals typically flows on the surface for 500 feet or less during early spring. In 2002, the surface flow only reached about 250 feet downstream of the portals.

Link Canyon, in the area of the portals, is typified by four types of stream gradient segments or reaches. The initial drainage segment, Segment 1, flows across a low gradient surface with a slope of approximately 3 percent (Plate 7-9). The drainage sits on top of the Castlegate Sandstone and the channel floors consist of bed rock with a thin covering of loose, fine to coarse grain sands and silts. Channels can be shallow and broad or narrow and deeply incised in the minimal soil cover. Surface water is observed flowing in this reach only after significant storm events or on a few warm days during the spring runoff. No significant riparian vegetation is associated with this reach of the drainage.

From the point where the drainage enters the canyon near spring GW-21 (which discharges from the Castlegate Sandstone) to a point approximately 1200 feet downstream, the gradient increases to approximately 12 percent. In this reach, Segment 2, the drainage is cutting through the Castlegate Sandstone and the channel floors are typified by very shallow soils consisting of sand. Bedrock is exposed at or near the surface in the channel walls in this reach. The channel itself is in the very bottom of the canyon and in locations where soil is present, it is deeply incised in the soils with steep, eroding banks. This area of the drainage is typically heavily grazed by livestock. Water flows from the springs for about 300 to 750 feet in the channel bottom before disappearing into the sands of the channel floor, into the bedrock, or evaporates. Riparian vegetation is supported in this reach beginning at spring Pines 100 and continuing downstream about 1200 feet. The riparian vegetation consists of alders, willows, wild rose, horsetails, etc. The riparian vegetation is limited generally to the floor of the channel and the spring areas (Plate 7-9). The riparian vegetation does extend further downstream than typical surface flows suggesting water does continue to flow in the subsurface downstream of where surface water disappears. The vegetation typical of this area has been described in Chapter 3 of this M&RP.

The third segment of the stream, Segment 3, is approximately 1500 feet long and extends from a point approximately 1200 feet below Pines 100 to a point approximately 250 feet below the Link Canyon Mine Portals. The slope of the gradient in this reach is approximately 50 percent. The

(Figure 7-4)

Surface Drainage Patterns

drainage cuts through the Blackhawk Formation and the upper Star Point Sandstone. This reach is typified by alternating sandstone ledges and shaley slopes with little to no soil cover. The channel contains large boulders, cobbles and gravel and at times is poorly defined. Surface water above the mine portals has only been observed in this reach during and shortly after significant storm events. Surface water flows downstream of the portals for a distance typically less than 500 feet. Riparian vegetation is located slightly upstream and for approximately 800 feet below the Link Canyon portals. This vegetation is typified by willow, alder, stinging nettle, rose, horsetail, carex, Kentucky Bluegrass, rush, and clematis. As in segment 2, the riparian vegetation is typically limited to the bottom of the channel or a short distance up the channel walls. This suggests that the water source for these plants is the water discharged from the mine into the channel and not an areal extensive aquifer discharging to the channel at numerous locations and elevations.

The final reach of the drainage, Segment 4, described herein runs from a point beginning approximately 250 feet below the portals to the USFS boundary and the south section line of Section 26, or approximately 2600 feet. The slope of the gradient in this reach is approximately 10 percent. The drainage channel cuts through the Mancos shale in this reach and typically has a floor of sandstone cobbles and boulders resting in fine to coarse sand and silt. The channel itself can be incised in the minimal soil cover or be broad and flat where bedrock is exposed and little soil cover is found. Surface water would flow in this reach only after significant precipitation events. However, in five years of monitoring the two sites, Link 001 (located near the base of the third stream segment) and 002 (located near the base of the fourth stream segment), surface water has not been observed in the channel.

Station locations are indicated on Plate 7-3. All other streams within the permit and adjacent areas are ephemeral, unless specified otherwise.

Based on channel-geometry measurements and a technique described by Fields (1975), Waddell et al. (1981) estimated that the historic average annual flow of Quitchupah Creek is approximately 3800 acre-feet immediately above the confluence with Link Canyon. With a drainage area of 85.4 square miles (Waddell et al., 1981), this results in a unit-area average annual streamflow of 44.5 acre-feet per square mile per year (AF/mi^2/yr) for Quitchupah Creek above Link Canyon.

The U.S. Geological Survey collected streamflow data from Ivie Creek from 1951 through 1961 at a station located approximately 11 miles south of the mine surface facilities. During the period of record, data published by the U.S. Geological Survey indicate that the average annual streamflow at this station was 2830 AF/yr. Based on a published drainage area of 50 mi^2, the unit-area average annual streamflow of upper Ivie Creek was 56.6 AF/mi^2/yr. This compares favorably with the unit-area yield of Quitchupah Creek and with the mean annual water yields presented by the Utah Division of Water Resources (1977).

Seasonal variations in historic streamflow in the vicinity of the lease area are portrayed graphically in Figure 7-5. The Muddy Creek station is located approximately 6 miles downstream from the confluence of Box Canyon and Muddy Creek while the Ivie Creek station was located about 11 miles south of the mine surface facilities. These trends (which are considered representative of perennial streams in the permit and adjacent areas) indicate that peak monthly stream flows in the area generally occur in May or June, probably as a result of snowmelt runoff. The Ivie Creek data also indicate that an additional rise in the monthly hydrograph occurs in July or August, probably as a result of summer thunderstorm activity.

Even though selected stations have been monitored for over eight years, no streamflow data are available for ephemeral drainages in the permit and adjacent area. When it does occur, ephemeral runoff in the area is expected to occur predominantly in the months of July, August, and September as a result of thunderstorm activity. These storms are expected to result in runoff with a short duration and high intensity.

Greens Hollow Tract

Surface runoff from the tract flows into tributaries of Muddy Creek and the North Fork of Quitchupah Creek. Watersheds for the tract include most of the Greens Canyon, Greens Hollow, Cowboy Creek, North Fork Quitchupah Creek and South Fork Quitchupah Creek watersheds. The main stem of Muddy Creek is perennial as it passes along the northern edge of the Greens Hollow tract. North Fork of Quitchupah Creek does not flow into Muddy Creek but does have perennial flow. According to USGS records the annual average flow for Muddy Creek near Emery is 37.5 cfs (USGS 2013). In 2001 the average flow was 33.2 cfs.

A loss/gain study for Greens Canyon and its tributaries, Greens Hollow and Cowboy Creek was done in 2001. The study showed losses for the streams in the Blackhawk Formation and Castlegate Sandstone. Cirrus was not confident that this study was representative of normal conditions. Quarterly field visits by Cirrus to stock ponds in the Muddy Creek Tract bounday from summer 2002 through fall 2003 showed most ponds being empty by early summer.

Cirrus did monitoring of surface water and as did the permittee, locations are shown on Plate 7-3 and the data is summarized in Appendix 7-27. Summaries include data for the South Fork of Quitchupah (Upper), U-Mud and MSTR-6.

Several small catchment ponds have been constructed in the permit and adjacent areas to capture water for stock watering. Those catchment ponds where water rights applications have been filed are located as shown on Plate 7-2. The catchment ponds capture water either from an adjacent spring or from snowmelt.

The Sufco mine has three UPDES discharge monitoring points. The locations of these points are shown on Plate 7-3.

UPDES monitoring point 001 represents an emergency mine discharge point that is used only in the event of a failure of the mine dewatering system. To discharge from this point, the emergency in-mine pump must be started and the valve on the discharge pipe must be manually opened. When the point is used, water is discharged into the East Spring Canyon 72-inch bypass culvert shown on Plate 7-6.

UPDES monitoring point 002 represents discharge from the East Spring Canyon sedimentation pond. Discharge from this point occurs only infrequently as a result of pond dewatering.

UPDES monitoring point 003 (equivalent to hydrologic monitoring station SUFCO-021) represents normal discharge from the underground workings into the North Fork of Quitchupah Creek. As indicated in the 1990 annual report, discharge at this point averaged approximately 550 gpm during the period of 1983 through 1990. From 1988 through 1990, this discharge rate generally increased from a pre-1988 rate of about 450 gpm to about 1,000 gpm (see Figure 7-6). Discharge rates tend to relate to coal production rates and are not seasonally affected.

Note that the waste-rock disposal area sedimentation pond does not have a UPDES permit since this is a total-containment, non-discharge facility (see ~~Volume 3~~ the Waste Rock Volume of this M&RP).

WATER QUALITY

Surface-water quality samples have been collected in the permit and adjacent areas from stations located on Quitchupah Creek, the North and South Forks of Quitchupah Creek, mine discharges into the North Fork of Quitchupah Creek, drainages to Muddy Creek and Box Canyon. Historical data from these sources are summarized in Appendices 7-4, 7-17 and 7-18.

Historical data collected from stations SUFCO-006 (upper South Fork of Quitchupah Creek) and SUFCO-007 (upper North Fork of Quitchupah Creek) indicate that water in the upper reaches of this drainage is predominantly a calcium-bicarbonate chemical type with an average TDS concentration that varies from about 330 to 470 mg/l. The pH of this water is slightly alkaline, averaging 7.9 to 8.0. Total iron concentrations at these stations typically ranges from 1.7 to 3.0 mg/l, with dissolved iron concentrations averaging 0.03 to 0.04 mg/l. Total manganese

(Figure 7-5)

Streamflow Probability of Selected Streams concentrations at these stations average 0.11 to 0.12 mg/l, with dissolved manganese concentrations averaging 0.02 to 0.05 mg/l.

Alkalinity typically exceeds acidity at these upper stations by a factor of approximately 25. TDS concentrations tend to be inversely proportional to flow, while total iron and manganese concentrations are typically directly proportional to flow. Consistent seasonal variations in pH, dissolved iron, and dissolved manganese concentrations are not apparent.

The historical mine discharge at SUFCO-021 (UPDES monitoring station 003) is a calcium-bicarbonate-sulfate water with an average TDS concentration of 603 mg/l and an average pH of 7.4. Sulfate concentrations in the mine-water discharge average 236 mg/l. This compares with an average sulfate concentration of 81 mg/l between stations SUFCO-006 and -007 and an average of 66 mg/l in the mine inflow (station SUFCO-062). This increase in sulfate (and TDS) in the mine-water discharge as compared with adjacent surface and underground water may be the result of dissolution of the calcium-sulfate based rock dust used in the mine.

Total and dissolved iron concentrations in the mine-water discharge average 0.08 and 0.03 mg/l, respectively. Total and dissolved manganese concentrations in this water average 0.02 and 0.01 mg/l, respectively. On the average, the alkalinity exceeds the acidity by a factor of approximately 20. The chemical data have not exhibited consistent seasonal variations.

At the mouth of the North Fork of Quitchupah Creek (SUFCO-042), the predominant ions are calcium, bicarbonate, and sulfate. The average historical TDS concentration at this location is 518 mg/l, with an average pH of 7.9. Total and dissolved iron concentrations at this station average 3.4 and 0.03 mg/l, respectively, with total and dissolved manganese concentrations averaging 0.08 and 0.01 mg/l, respectively. Alkalinity exceeds acidity by a factor of more than 20.

TDS concentrations at SUFCO-042 are generally inversely proportional to flow, while total iron and manganese concentrations are directly proportional to flow. Seasonal variations in pH, dissolved iron, and dissolved manganese are not apparent.

Stations SUFCO-046 and SUFCO-041 monitor Quitchupah Creek above East Spring Canyon and above the North Fork of Quitchupah Creek, respectively. Average historical TDS concentrations at these stations vary from 697 to 685 mg/l, with pH averaging 7.6 to 8.0. Water in Quitchupah Creek is of mixed chemical type. Average total iron concentrations range from 0.28 mg/l at the upstream station to 3.76 mg/l at the downstream station. Average dissolved iron concentrations range from 0.03 to 0.04 mg/l at the two stations. Total manganese averages 0.08 at both stations, with dissolved manganese ranging from 0.06 mg/l at the upstream station to 0.02 mg/l at the downstream station.

Alkalinity typically exceeds acidity in Quitchupah Creek by a factor of at least 25. Flow-TDS and flow-total metal relationships are as indicated above. Seasonal variations in pH, dissolved iron, and dissolved manganese are not apparent.

The historical chemical quality of surface water in East Spring Canyon at station SUFCO-047A is similar to that of Quitchupah Creek at SUFCO-046. The water is of mixed chemical type, with an average TDS concentration of 724 mg/l and an average pH of 7.4. Total and dissolved iron concentrations average 0.43 and 0.04, respectively, with total and dissolved manganese concentrations averaging 0.04 and 0.02, respectively. Alkalinity typically exceeds acidity in East Spring Canyon by a factor of approximately 20. Flow-TDS and flow-total metal relationships are as indicated above. Seasonal variations in pH, dissolved iron, and dissolved manganese are not apparent.

The historical chemical quality of streamflow in Box Canyon (as monitored at station SUFCO-090) contains an average TDS concentration of 93 mg/l and an average pH of 7.1. No total iron or manganese data are available. However, dissolved iron and manganese concentrations have averaged 0.27 and 0.04 at the station, respectively. The data base is insufficient to assess seasonal variations. However, trends between flow, TDS, and total metals are anticipated to be as described for the North and South Forks of Quitchupah Creek. Data collected from monitoring sites Pines 407 and Pines 408 are included in Appendices 7-17 and 7-18.

As a general point of comparison the surface-water analytical data were compared to primary and secondary drinking water standards. With the exception of two slight exceedances of the barium standard of 1.0 mg/l (one at SUFCO-007 and one at SUFCO-041), no exceedances of the primary drinking water standards occurred at the monitored stations. Exceedances of the secondary drinking water standards occurred for both sulfate and TDS. With the exception of the mine discharge, these exceedances are likely due to dissolution of marine salts in the sediments and outcropping rocks (Waddell, 1979 and Doelling, 1972).

7.2.4.3 Geologic Information

Geologic information related to the permit and adjacent areas is presented in Chapter 6 of this M&RP.

7.2.4.4 Climatological Information

Climatological data have been collected from a station location at the mine surface facilities since July 1986. Historical monthly summaries of these data are presented in Appendix 7-5. These and other regional data are summarized in this section. Updated climatological data have been submitted to the Division in annual reports.

Precipitation. Based on regional data, normal annual precipitation at the mine is about 18 inches per year (Utah Division of Water Resources, 1977). Approximately 42 percent of this precipitation falls in the period of May through September, with the remainder falling in the October through April period, primarily as snow (Utah Division of Water Resources, 1977).

During the historical period of record at the mine site, precipitation has been below the regional normal cited above, averaging 12.51 inches per year (see Appendix 7-5). Average monthly precipitation at the mine has ranged from 0.59 inch in June to 1.65 inches in August, with the August peak being the result of summer thunderstorm activity. Snow cover is typically on the ground from September through May.

Wind. The station closest to the mine that reports wind data is located at Gunnison, Utah (approximately 28 miles northwest of the mine). Due to the mountainous conditions in the area, the wind data collected at this station are not considered representative of the mine site. Periodic observations by mine personnel suggest that the prevailing wind at the mind is up the local canyons (i.e. south to north at the mine surface facilities).

Temperature. The normal annual temperature at the Salina, Utah station (located 24 miles west of the mine) is 49.5° F (National Weather Service, 1989). Seasonally, this temperature varies from a normal monthly low of 27.6° F in January to a normal monthly high of 73.7° F in July. During the period of record, temperatures at the mine have ranged from a low of -19° F in February 1989 to a high of 92° F in July 1989.

7.2.4.5 Supplemental Information

No supplemental information is required at this time.

7.2.4.6 Survey of Renewable Resource Lands

The existence and recharge of aquifers in the permit and adjacent areas is discussed in Section 7.2.4.1 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 7.2.8 of this M&RP.

7.2.4.7 Alluvial Valley Floor Requirements

Information regarding the presence or absence of alluvial valley floors in the permit and adjacent areas is presented in Chapter 9 of this M&RP.

7.2.5 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.

7.2.6 Modeling

No numerical groundwater or surface water modeling was conducted in support of this M&RP.

7.2.7 Alternative Water Source Information

No surface mining has been or will be conducted in the permit and adjacent areas. Therefore, this section does not apply to the SUFCO Mine.

7.2.8 Probable Hydrologic Consequences

This section addresses the probable hydrologic consequences of coal mining and reclamation operations in the mine permit and adjacent areas. Mitigating measures are discussed generally in this section and in detail in Section 7.3 of the M&RP.

7.2.8.1 Potential Impacts to Surface and Groundwater

Potential impacts of coal mining on the quality and quantity of surface and groundwater flow may include:

- Contamination from acid- or toxic-forming materials;
- Increased sediment yield from disturbed areas;
- Increased total dissolved solids concentrations;
- Flooding or stream flow alteration;
- Impacts to groundwater or surface water availability;
- Hydrocarbon contamination from above ground storage tanks or from the use of hydrocarbons in the permit area;
- Contamination of surface and groundwater from road salting; and

- Contamination of surface water from coal spillage due to hauling operations.

These potential impacts are addressed in the following sections of this M&RP.

7.2.8.2 Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of this M&RP. Baseline hydrologic information is presented in Sections 7.2.4.1 and 7.2.4.2 of this M&RP. The baseline monitoring sources are believed to be representative of existing ground water and surface water. An additional inventory is not planned unless circumstances dictate a need for change.

7.2.8.3 PHC Determination

Potential Impacts to the Hydrologic Balance. Potential impacts to the hydrologic balance are addressed in the following subsections of this M&RP and in Appendices 7-17, 7-18, 7-19, 7- 20 and 7-24. Appendices 7-18, 7-20 and 7-24 contain PHC determinations for mining activities in the Pines Tract, SITLA Muddy Tracts and West Coal Lease Modifications, respectively.

Acid- or Toxic- Forming Materials. Information on acid-and toxic-forming materials is presented in Chapter 6. These data reveal boron, sodium absorption ratio, and specific conductance exceedances of the Table 2 guidelines for management of topsoil and overburden (Leatherwood and Duce, 1988) in waste rock from the SUFCO mine. As noted in Section 7.2.4.2 of this M&RP, the alkalinity of the mine discharge water typically exceeds the acidity of this water by a factor of 20. Additionally, mine discharge water typically meets the standards for water quality for the state of Utah (Utah Water Quality Board, 1987). Thus, analytical data obtained from mine-water discharges indicate that although potential exists in localized portions of the mine for acid- or toxic-forming materials to be present, there has been no known impact to the surface or groundwater in the permit and adjacent areas.

Sediment Yield. The potential impact of mining and reclamation on sediment yield is an increase in sediment in the surface waters downstream from disturbed areas. Sediment-control measures (such as sedimentation ponds, diversions, etc.) have been installed to minimize this impact. These facilities are regularly inspected (see Section 5.1.4) and maintained.

Data on file with the Utah Department of Environmental Quality (formerly the Utah Division of Environmental Health) indicate that waters discharging from the mine have typically not exceeded the total suspended solids standards (40 CFR 434) of 70.0 mg/l maximum, 35.0 mg/l 7-day average, and the 25.0 mg/l average daily. Samples of sedimentation pond discharge have rarely exceeded the maximum standard with the exceedances ranging from 26.0 to 261 mg/l. Except under unusual circumstances, the average total suspended solids concentration of the sedimentation pond discharge is less than the average daily standards. Thus, although a limited number of exceedances of the standards have occurred, the sediment-control measures at the mine are considered effective at minimizing the impacts of increased sediment yield on adjacent streams.

Sediment yields may increase locally due to subsidence. Subsidence cracks which intersect ephemeral drainages with steep gradients could, for a short period of time, increase the sediment yield of the stream. However, this sediment increase would cause the crack to be quickly filled, recreating pre-subsidence stream channel conditions. Thus, the potential impact to sediment yield would be minor and of short duration.

An assessment of the Alternative Sediment Control Measures to be implemented during reclamation was performed as indicated in Appendix 7-15. These calculations indicate that the implementation of each sediment control measure substantially reduces the amount of sediment erosion from the reclaimed areas, to the point that the mulch theoretically inhibits soil loss more effectively than a baseline level of undisturbed ground cover. In fact, the combination of surface soil preparation, an application of wood fiber hydromulch at 2000 pounds per acre, and the use of silt fences results in a 37% to 85% reduction of soil erosion below that which would be expected from naturally vegetated grass/sage slopes. Thus, sediment control measures to be implemented during reclamation will preclude adverse impacts to the environment.

In the area of the Link Canyon Portal and Link Canyon Substation No. 1 and No. 2 pads and access roads, sediment yield from the disturbed areas will be controlled with berms and/or silt fences. The calculations supporting the use of berms and /or silt fences for these areas are presented in Appendix 7-15. Undisturbed runoff from above the Link Canyon Portal pad area that naturally flowed down the Link Canyon drainage will be diverted under the pad area by the use of a diversion culvert and will be channeled back into the existing Link Canyon drainage. Undisturbed runoff from above the substation pad areas that naturally flowed directly into the existing Link Canyon Road inside ditch will be diverted around the substation pad areas by the use of a diversion ditch and will be channeled back into the existing Link Canyon Road inside ditch. Sediment yield from the undisturbed drainage ditch will be controlled with a silt fence. From the point that the Substation No. 2 undisturbed drainage reenters the existing Link Canyon Road ditch the existing road ditch drainage flows for about 30' along the inside of the road before the flow is diverted across the road by an existing water bar were the flow is directed toward the channel at the bottom of Link Canyon. This drainage is by Division definition an intermittent stream. However, water only flows in this canyon in the substation areas as the result of snow melt runoff or the occasional summer thunderstorm.

Acidity, Total Suspended Solids, and Total Dissolved Solids. Probable impacts of mining and reclamation operations to the acidity and total suspended solids concentrations of surface and groundwater in the permit and adjacent areas were addressed previously in this section. Impacts to water quality parameters within the Pines Tract area are addressed in Appendix 7-18.

Data presented in Appendix 7-4 and summarized in Section 7.2.4.1 of this M&RP indicate that the average TDS concentration of water entering the mine (as measured at SUFCO-062) is 397 mg/l. This a calcium-bicarbonate water with an average sulfate concentration of 63 mg/l. As noted in Section 7.2.4.2, the average TDS concentration of water discharging from the mine (as measured at SUFCO-021) is 667 mg/l (with a historical range of 350 to 970 mg/l). This is a calcium-bicarbonate-sulfate water with an average sulfate concentration of 277 mg/l (with a historical range of 40 to 469 mg/l).

These data indicate that the TDS concentration of water flowing through the mine increases by a factor of approximately 1.6. The sulfate concentration of this water increases by a factor of about 3.5. As noted in Section 7.2.4.2, this increase in TDS and sulfate concentrations may be the result of dissolution of calcium-sulfate rock dust used in the mine.

Subsidence may cause some surface water to be diverted into the groundwater. As the water flows slowly through the ground, the water dissolves the salts available in the formations and TDS concentrations increase. When the diverted water is later discharged to the surface, TDS concentrations may be higher than if it had flowed over the surface. Due to the nature of ephemeral streamflow, these subsidence-caused diversions would be small in volume. When a fracture becomes sealed with bentonitic materials available in the lease area (Thiros and Cordy, 1991), the diversion either ceases or flows into a higher stratigraphic unit. Thus, potential impacts would be minor and not of significant concern.

The impact of the TDS and sulfate concentration increases on surface-water resources in the permit and adjacent areas is considered minimal for three reasons. First, surface water in the permit and adjacent areas has been classified in the Utah Department of Environmental Quality Wastewater Disposal Regulations as Class 3a and 4 water (protected for cold water aquatic life and agricultural uses, respectively). No sulfate discharge standard exists for either of these two classifications. The only TDS standard is for Class 4 water, with a discharge limitation of 1200 mg/l. Thus, the mine water does not exceed the applicable discharge standard and small amounts of surface water diverted through the groundwater system would not cause exceedances of the applicable standards.

Second, according to data presented in Section 7.2.4.2, although the discharge of mine water into the North Fork of Quitchupah Creek increases the TDS and sulfate concentrations of the receiving water (compare data from SUFCO-006, SUFCO-007 and SUFCO-042), the TDS concentration of the discharge water is less than that of Quitchupah Creek above the influence of the mining operation (compare data from SUFCO-046). As a result of these factors, the impacts of increased TDS and sulfate concentrations in the mine-water discharge relative to the adjacent natural water are not considered significant.

Finally, as indicated on Plate 6-1, surface water in the North Fork of Quitchupah Creek flows across Mancos Shale immediately downstream from the mine discharge point. Similarly, Quitchupah Creek crosses Mancos Shale immediately downstream from the confluence with East Spring Canyon. Since the Mancos Shale is a gypsiferous formation, sulfate and TDS concentrations are naturally high in areas underlain by this unit. Thus, the additional input of these constituents from the mine waters to local streams is considered minimal.

As indicated previously, tension cracks created by subsidence may locally increase the rate of downward percolation of groundwater. However, as indicated by Mayo in Appendix 7-17, the potential for increased vertical percolation of groundwater due to subsidence is not considered to be significant and should have no impact on mine discharge water quality.

No subsidence is anticipated to occur in the Link Canyon Substation pad area. Therefore, disturbance in this area is not anticipated to adversely effect groundwater. Surface water will not be adversely effected in this area since runoff will be treated prior to discharge, thus limiting the amount of total suspended solids. Additionally, the soils in the area are not toxic or acid forming and the total increase of dissolved solids added to the runoff from the limited area of the pad will not be significant. The receiving waters pass over large areas of exposed Mancos Shale before it is put to beneficial use. Therefore, the contribution of TSS and TDS from the pad area when compared to the contribution of the in-place soils and shale bedrock will be insignificant.

Flooding or Streamflow Alteration. Runoff from all disturbed areas is treated through sedimentation ponds or other sediment-control devices prior to discharge to adjacent undisturbed drainages. Three factors indicate that these sediment-control devices minimize or preclude flooding impacts to downstream areas as a result of mining operations:

1. The sediment-control facilities have been designed and constructed to be geotechnically stable. Thus the potential is minimized for breaches of the sediment-control devices to occur that could cause downstream flooding.

2. The flow routing that occurs through these sediment-control devices reduces peak flows from the disturbed areas. This precludes flooding impacts to downstream areas.

3. By retaining sediment on site in the sediment-control devices, the bottom elevations of stream channels downstream from the disturbed areas are not artificially raised. Thus, the hydraulic capacity of the streams channels is not altered.

Following reclamation, stream channels will be returned to a stable state (see Section 5.4.2.2). The reclamation channels have been designed to safely pass the peak flow resulting from the 100-year, 24-hour storm. Thus, flooding in the reclaimed areas will be precluded. Interim sediment-control measures and maintenance of the reclaimed areas during the post-mining period will preclude deposition of significant amounts of sediment in downstream channels following reclamation, thus maintaining the hydraulic capacity of the channels and precluding adverse flooding impacts.

The mine has been designed to minimize subsidence impacts to perennial streams (see Section 5.2.5.1). Any material damage to the stream channel will be mitigated. Streamflow volume in the North Fork of Quitchupah Creek will, however, increase due to mine water discharge.

Mine water discharge to the North Fork of Quitchupah Creek has increased streamflow by over 1000 gpm (2.25 cfs). Waters encountered in the Pines Tract will be pumped to the Quitchupah discharge point. The worst case flow increase is estimated to be approximately 3.75 cfs. Once mining has ceased, the mine will be sealed and no discharges will occur. The streamflow volume will return to pre-mining discharge levels. Increased flow to the North Fork of Quitchupah during seasonal flow conditions are addressed by Mayo in Appendix 7-17.

Subsidence tension cracks that propagate to the surface, will increase the secondary porosity of the formations overlying the SUFCO mine. Thiros and Cordy (1991) state that bentonitic shale and plastic flow in mudstone within the perching layers could possibly slow or stop the downward movement of groundwater. If these cracks do not become blocked with bentonite, recharge to aquifers that feed spring flow may increase. Thus, subsidence may contribute to increases in streamflow.

Subsidence may decrease spring flow if the perched aquifer which supplies the spring is intersected by tension cracks, allowing groundwater to drain to underlying strata (Thiros and Cordy, 1991). Subsidence has occurred beneath East Spring (monitoring station 001), but no major changes in flow rate or water quality have been detected from 1985 to 1986 (Thiros and Cordy, 1991). Groundwater monitoring data (Appendices 7-4 and 7-17) indicate that flow rates of this spring have declined from 1987 to 1995. This decline in flow, however, is likely due to the drought conditions of the last several years (Appendix 7-5). Flow rates from other springs currently monitored by SUFCO, but located in unsubsided areas (057A and FS-109), have also declined during the last several years (Appendices 7-4 and 7-17).

Subsidence will occur in areas occupied by ephemeral and perennial stream channels. According to Thiros and Cordy (1991), surface water flow to natural drainages has the potential of being intercepted by subsidence fractures that extend to the land surface. In addition, the broad depressions created by subsidence may locally retain runoff that would normally discharge from an area. Although surface cracks that result from subsidence in the lease area tend to heal with time (see Appendix 5-4), stream flows may be partially intercepted prior to completion of the healing process. However, the following factors indicate that the impact of subsidence on streamflow will be minimal:

1. Bentonitic shale and plastic flow in mudstone within perching layers could possibly slow or stop the downward movement of previously perched groundwater (Thiros and Cordy, 1991).

2. Field observations indicate that there are no sustained above normal inflows in the mine. Thus, flow along fractures is either from a relatively small source, or the conduits become sealed quickly.

3. Ephemeral streamflow in the area is sporadic, allowing significant periods of time which may allow for surface cracks to heal between flow events.

4. Ephemeral streamflow typically carries a high sediment load. During precipitation runoff events, perennial streams will also carry a high sediment load. This sediment will fill remaining cracks. As the cracks heal, the potential for interception of streamflow is minimized.

5. The depressions created by subsidence are sufficiently broad that changes in slope are not typically of an ample magnitude to cause ponding in anything other than local areas. If ponding does occur, the shallow depressions will fill with sediment quickly due to the periodic high sediment load of streams and the drainage will return to the previous pattern.

Groundwater and Surface Water Availability. The potential impacts of mining on reductions in surface-water availability are discussed above. As indicated, these impacts are not considered to be significant.

As noted in Section 7.2.4.2, groundwater is encountered in the SUFCO mine and pumped to the surface, generally into the North Fork of Quitchupah Creek at UPDES station 003.

According to Mayo (Appendix 7-17), the rate of discharge from the mine has increased since 1987 from approximately 1.0 cfs (450 gpm) to about 3.56 cfs (1,600 gpm).

The increase in flow into and out of the mine is considered to be the result of increased coal production. The primary method of mining converted from room-and-pillar to longwall in October 1985. As a result of this change, production in the mine increased (see Figure 7-6). With the increase in production, new areas were mined at an increasingly higher rate. According to Mayo (Appendix 7-17), the mine discharge hydrograph shows that the rate of mine water discharge does not increase as the total area of the mine increases, but rather, the rate of discharge is related to the amount of recently mined areas.

As indicated in Section 5.2.3 of this M&RP, long-term production from the SUFCO mine is expected to average about 6 million tons. Projecting this production rate and the mine discharge rate on

Figure 7-6, it is estimated that long-term discharge of groundwater from the mine will average approximately 2.6 cfs (1,200 gpm).

It should be noted that the discharge of mine water to a stream probably results only in a local increase in flow and not a basin-wide increase. As noted on Plate 6-1, the Mancos Shale outcrops in the North Fork of Quitchupah Creek just upstream from the mine-water discharge point and in Quitchupah Creek above the confluence with East Spring Canyon. The shales of this formation have a low permeability (Waddell et al., 1981), thus forcing groundwater to the surface as streamflow. Thus, although the discharge of water from the mine may result in a local loss of groundwater and gain in surface water, this discharge does not disrupt the hydrologic balance of the basin.

The long-term mean mine discharge to North Fork Quitchupah Creek is 980 gpm and discharge varies between 460 and 1760 gpm. The mean upstream flow during high-flow conditions (June) is 2,650 gpm and during low-flow conditions (October) the flow is 290 gpm. Thus, mine discharge represents a mean increase in creek discharge of 37% and 337% for June and October, respectively. The mean low flow discharge measured at site 042, 5 miles downstream from the mine discharge point, is 950 gpm. This suggests that the lower reaches of North Fork Quitchupah Creek could go dry in late summer and early fall without the contribution of mine water to the stream.

Subsidence has occurred in the lease area (Plate 5-10). More subsidence is expected to occur in the future as longwall mining progresses. Fractures that remain open or fill with permeable material would locally increase the hydraulic conductivity of the strata. However, when tension fractures intercept mudstones or shale units that contain bentonitic or montmorillonite clays, these fractures become sealed, stopping vertical flow (Thiros and Cordy, 1991). When tension fractures intercept strata that are more brittle or less amenable to sealing by clays, such as the Castlegate Sandstone, these fractures will heal naturally by filling in with silt and organic material such as sticks, pine needles, pine cones, and pine cone fragments. This natural healing could take longer to seal the cracks with the potential to impact water resources for a period of time. A discussion of the potential impacts to water resources due to subsidence is provided in Section 7.2.8.3 of this

M&RP and in Appendix 7-17. DeGraff (Appendix 5-4) indicates that tension cracks in the lease area typically heal quickly. There are no sustained above normal inflows in the mine due to mining or subsidence. Thus, most fractures in the lease area appear to become sealed in a relatively short period of time. Intersection of locally perched aquifers by subsidence cracks could divert groundwater from a spring. Water will not be lost from a specific basin, but may become diverted within the basin.

(Figure 7-6)

Mine Discharge and Coal Production Rates

The discharge from the abandoned Link Canyon Mine was to be maintained during and after utilization of the western portal for Sufco Mine access. The water naturally discharging from the abandoned mine is not considered to be a UPDES mine discharge point by the Utah Division of Water Quality so long as the water is not contaminated or comes in contact with Sufco mining related activities. The initial plan by Sufco was to maintain the flow of water from the flooded old works to the abandoned eastern portal and out the rehabilitated western portal. However, when the old works were accessed, both from inside the Sufco Mine and the surface, very little water was encountered and the old works did not appear to be flooded. The majority of water encountered during rehabilitation efforts was located just inside the western portal. A small pond of water had formed behind a roof fall in the old mine. It was apparent that shallow ground water or surface water entered the mine just in by the portals and upgradient of the roof fall, forming the small pond. Once the roof fall was removed and the water drained, water ceased discharging from the western portal. The volume of water discharging from the eastern portal area also appeared to decrease. It further appears that most of the water that currently seeps into the old workings near the portal evaporates before it can accumulate and discharge out the western portal. Small volumes of runoff and ground water still accumulates in the eastern portal area and can be seen in the spring and fall discharging over the rock ledges below the portal.

The riparian vegetation in the area of the Link Canyon portals is feed not only by the discharge from this portal but also by subsurface flow discharged by springs above the mine in the Castlegate Sandstone. Thus, the riparian vegetation above and below the west portal was sustained during site construction by subsurface flows from the upgradient springs and flows from the east portal.

Water, if any, that enters the portion of the Link Canyon Mine utilized by Sufco will be discharged at UPDES discharge point 003. The Link Canyon Portal elevation is 7663 feet and the elevation where the old works will connect to the existing Sufco Mine is 7658 feet with the mine average dip being 2% N45°W. As of August 2005, water had not accumulated in the abandoned Link Canyon Mine and draining and discharging the water through the existing Sufuco Mine has not been necessary.

The activity related to reopening the western Link Canyon portal should not have a significant negative impact on surface water flows in Link Canyon Creek. While the creek has been designated as an intermittent stream under the R645 rules as a result of its drainage area size, the stream functions primarily as an ephemeral stream (Thiros and Cordy, 1991). As described in Section 7.2.4.2 of this chapter, the majority of the stream's reaches typically only flow as a result of runoff from significant precipitation events and during brief periods of snow melt runoff. The two surface water sites, Link 001 and Link 002 which are located above and below the portals (Plate 7-3), did not have measurable or monitorable flows during quarterly monitoring episodes from 1999 through 2002 (Erik Petersen, personnel communication, November 2002). Observable surface flows in the stream are generally limited to just below the developed springs *(Pines 100 and GW-21)* near the head of the canyon and just below and adjacent to the Link Canyon Portals. In both locations water flow or moist soils have been observable for only a few hundred feet below the source. Table 7-1A details the dates, flows, and monitoring personnel for sites Link 001, Link 002, Link Portal West and Link Portal East.

Vegetation in the Link Canyon channel below the mine will be photographically monitored on a quarterly basis, except in the winter months, to determine what, if any, impacts the reduction of discharge from the western portal has on the vegetative community. The vegetation monitoring was started in the summer of 2005 and will continue through the reclamation of the portals. The general health of the willows, Woods Rose, clematis, and wire grasses present in the vegetative community will be observed and the observations reported in the mine's annual report. If significant changes occur in the vegetation monitored, these changes will be reported to the Division and the Forest Service. A plan may be developed and instigated at that time to mitigate any damages to the vegetation as a result of mining activities. Refer to Section 3.2.2.2 for additional vegetation information.

Flows from the Link Canyon portals have been measured periodically since 1977 with discharges ranging from 5 gpm (estimated by Hydrometrics, 1977) to no discharge (Petersen 2002). Samples of the water discharged from the west portal have been obtained and analyzed by Thiros and Cordy (1991), Mayo and Associates during the Pines Tract EIS process (1998), and recently by Petersen (2002, Appendix 7-4).

TABLE 7-1A

FLOW OBSERVATIONS IN LINK CANYON

WATER MONITORING SITES

Link 001, Link 002, Link Portal West, and Link Portal East

LOCATION	DATE OF OBSERVATION	FLOW (gpm)	SAMPLER
Link 001 and Link 002	06-03-97	No Flow	E. Petersen
	10-29-97	No Flow	E. Petersen
	11-03-97	No Flow	E. Petersen
	06-29-98	No Flow	E. Petersen
	09-16-98	No Flow	E. Petersen
	11-04-98	No Flow	E. Petersen
	06-22-99	No Flow	E. Petersen
	08-25-99	No Flow	E. Petersen
	10-28-99	No Flow	E. Petersen
	06-01-00	No Flow	E. Petersen
	08-22-00	No Flow	E. Petersen
	11-14-00	No Flow	E. Petersen
	06-13-01	No Flow	E. Petersen
	08-22-01	No Flow	E. Petersen
	10-01-01	No Flow	E. Petersen
	05-18-02	No Flow	E. Petersen
	09-26-02	No Flow	E. Petersen
	10-08-02	No Flow	E. Petersen

TABLE 7-1A (Continued)

FLOW OBSERVATIONS IN LINK CANYON

WATER MONITORING SITES

Link 001, Link 002, Link Portal West, and Link Portal East

LOCATION	DATE OF OBSERVATION	FLOW (gpm)	SAMPLER
Link Portal - West	09-17-77	5 (estimated)	Hydrometrics
	08-04-86	1.5	Thiros & Cordy*
	08-20-86	2.2	Thiros & Cordy*
	09-15-86	1.6	Thiros & Cordy*
	11-04-86	1.3	Thiros & Cordy*
	05-11-87	2.0	Thiros & Cordy*
	06-16-87	1.5	Thiros & Cordy*
	07-20-87	1.7	Thiros & Cordy*
	09-08-87	1.6	Thiros & Cordy*
	09-16-98	1.0 (estimated)	Erik Petersen
	12-07-01	0.5 (estimated)	Chris Hansen
	10-26-02	No Flow - Standing Water	Erik Petersen
	10-30-02	No Flow - Standing Water	Erik Petersen
	11-06-02	No Flow - Standing Water	Erik Petersen
	11-15-02	No Flow - Standing Water	Erik Petersen
Link Portal - East	12-07-01	0.5 (estimated)	Chris Hansen
	10-26-02	No Flow - Standing Water	Erik Petersen
	10-30-02	No Flow - Standing Water	Erik Petersen
	11-06-02	No Flow - Standing Water	Erik Petersen
	11-15-02	No Flow - Standing Water	Erik Petersen

Prior to disturbing the portals, additional samples have been obtained from both the east and west portals in October and November 2002. One sample from each portal was obtained for four consecutive weeks. No surface flow was present in the summer of 2002 at either of the portals. However, a small pool of standing water was present at the mouth of the west portal through most of the year. The samples were obtained by first excavating a depression near the mouth of the east portal and allowing water to gradually fill the depression and by sampling the standing water at the mouth of the western portal. These samples were obtained as baseline samples in compliance with a request from the Forest. The samples have been analyzed according to the Division's guidelines for baseline water monitoring samples. Copies of the sample analyses results for samples obtained on October 26, October 30, November 6, and November 15, 2002 are included in Appendix 7-4. Included in Appendix 7-4 is a brief report by Erik Petersen of Petersen Hydrologic, Inc. that discusses the various sampling events, the results of the sample analyses, and an interpretation of the data as it relates to the origin of the water in the Link Canyon Mine.

Mr. Petersen discusses in his report that water issuing from the Link Canyon portals is likely not sourced from the springs at the head of the canyon but probably from surface water that enters the mine through the weathered bedrock near the surface. It appears that during periods of normal or greater than normal precipitation, the water discharged from the mine has a TDS level of near 500 mg/l. However, in drought years, as has occurred in the area beginning in 1999 and continuing through 2002, the TDS levels in the water naturally rises due to a lack of fresh water flushing of the abandoned mine workings water. Hence, the samples obtained in the fall of 2002 had TDS concentrations greater than 1400 mg/l.

A hydrograph of the discharges from the Link Canyon Mine is provided in the USGS report by Thiros and Cordy (1991). This hydrograph, along with the additional data collected by Mayo and Associates and Erik Petersen suggest the discharge from the mine is influenced by seasonal changes in precipitation. Significantly, the flow from the mine has nearly ceased as a result of the area drought which began in 1999 and has continued through at least 2002.

Water discharged from the mine will continue to be monitored at sites Link Portal West and Link Portal East, as part of the quarterly water monitoring program. Significant changes in water chemistry and the apparent causes will be reported to the Division.

The only actual loss of groundwater from the hydrologic balance is that water which is the difference between the average as-shipped moisture minus the inherent moisture or in-situ moisture of the coal and leaves the basin upon mining. Based on an average coal moisture loss of groundwater content of 1.8 percent and a long-term coal production rate of 6 million tons per year, approximately 80 AF/yr of groundwater is removed from the basin. This represents about 2 percent of the average annual flow of Quitchupah Creek above Link Canyon.

Several springs and stream locations in the lease area are monitored for quantity and quality as prescribed by the M&RP water monitoring program. Analysis of the monitored flows indicated that very little impact has occurred to springs and streams. Erik Petersen of Petersen Hydrologic, Inc evaluated the flow data collected from several springs and surface flows in the Box Canyon drainage. His evaluation was forwarded to Sufco in the form of a letter report dated August 14, 2003 and is included in Appendix 7-19. Mr. Petersen determined that since mining began in the Pines Tract, a few the area springs have exhibited an increase in flow during a period of prolonged drought. He also concluded that perhaps one spring, Pines 303, in the lower portion of the Box Canyon, may have experienced reduced flows as a result of mining activities. However, because of the prolonged drought in the area that began in 1998, it is not possible to determine with certainty whether mining activities, drought conditions, or both have resulted in the loss of spring flow. A loss in flow from this spring was a predicted possibility described in the Pines Tract EIS. The loss of flow from this spring(less than 4 gpm) has apparently not adversely affected area vegetation or wildlife. Because of the increased discharge of springs farther up canyon, the loss of the less than the 4 gpm contribution of ground water from Pines 303 to Box Canyon Creek is insignificant to the total flow of the creek. No water rights were found to have been filed on this spring discharge.

Mr. Petersen has noted an increase in the flow of springs Pines 209 and 212 and in the flow of the Main Fork of Box Canyon Creek that appears to coincide with mining in the western portion of the

Pines Tract. He reasons that the increase in spring flow is related to subsidence enhanced recharge or hydraulic conductivity of the aquifers sourcing the springs. The increase in spring flow has resulted in the increase in flow in the Main Fork of Box Canyon Creek. This has been noted as a positive impact to the creek during a time of drought. Analysis of the flow data presented by Petersen suggests the increase in flow from these springs may be short lived. He has also indicated that flow from these springs will not cease but should return to near pre-mining rates. In fact, the data presented in his August 14, 2003 letter report suggests the flow rates may already be beginning to return to pre-mining rates.

Greens Hollow Tract

Although subsidence has occurred beneath springs and streams in areas adjacent to the Greens Hollow Tract, few springs or streams have been permanently effected. The sedimentary geology is the dominant factor influencing the hydrologic system of the area, determining how subsidence affects the surface and subsurface water resources. The geologic units of importance in this commentary are the Blackhawk Formation, the Castlegate Sandstone, Price River Formation and North Horn Formation. Widespread subsidence impacts across the Greens Hollow tract would not be expected. Refer to Appendix 7-4, FSEIS pages 147 - 150, highlighted portions.

"The overall risk for permanent water loss at any spring located with the tract would be relatively low. If the flow at a particular spring is diminished as a result of subsidence-induced surface tensile fracture, the ground water would not be drained to the mine or lost from the hydrogelogic system" (FSEIS, 2015).

"Petersen (2009) provides an assessment of subsidence impacts observed in the adjacent Pines Lease Tract and local confirmation of Wilkowske et. al. (2007) indicate that there is minimal risk of water loss from perennial streams where overburden cover is great the 600 feet and on the order of 60 times mining height." FSEIS, 2015).

Potential Hydrocarbon Contamination. Diesel fuel, oils, greases, and other hydrocarbon products are stored and used at the site for a variety of purposes. Diesel and oil stored in above-ground tanks at the mine surface facilities may spill onto the ground during filling of the storage tank, leakage of the storage tank, or filling of the vehicle tank. Similarly, greases and other oils may be spilled during use in surface and underground operations.

The probable future extent of the contamination caused by diesel and oil spillage is expected to be small for three reasons. First, because the tanks are located above ground, leakage from the tanks can be readily detected and repaired. Second, spillage during filling of the storage or vehicle tanks is minimized to avoid loss of an economically valuable product. Finally, the Spill Prevention Control and Countermeasure Plan presented in Appendix 7-6 provides inspection, training, and operation measures to minimize the extent of contamination resulting from the use of hydrocarbons at the site.

The potential for hydrocarbon contamination of the environment at the Link Canyon Substation or the reopened Link Canyon Mine Portal is minimal since no fuels or lubricants will be stored at this site. If a catastrophic failure of the transformers at the substation occurred, the minimal volume of oil would be contained behind the berm to be built around the equipment.

Periodically due to difficult recovery conditions or roof collapse, mining equipment is abandoned underground. Abandoned mining equipment locations are shown on Figure 7-7. Prior to leaving equipment underground, lubricating and hydraulic fluids are removed to the extent possible. Since the equipment is steel and not too different compositionally from the roof support throughout the mine, contamination to ground water from abandoned equipment will cause minimal, if any, disturbance to the hydrologic balance within the permit and adjacent areas and is not expected to cause material damage outside the lease area. Assuming the mine were to flood and the abandoned equipment were to be covered with water, several probable results and impacts can be evaluated:

1. Flooding of the abandoned mine might be relatively rapid, but once flooded, flow of ground water into, through, and out-of the void spaces of the mine should be slow.

2. If steel or other metals in the equipment were to oxidize, it would be at a very slow rate and the amount of iron and other metals added to the ground water at any one time would be very small.

3. Oxides of most metals are insoluble or slightly soluble in water. At temperatures expected in the mine, metal oxides would tend to precipitate as solids within the mine rather than flow in solution in the ground water. If any metal were to go into solution, concentrations would be highest near the abandoned equipment, but the volume of water in the flooded mine would dilute concentrations outside the immediate vicinity of the equipment.

4. Because of dilution and dispersion, natural seasonal fluctuations, changes in water quality would not be expected to be large enough to be detected at the surface at springs, ground-water baseflows to streams, or in discharges from the mine.

Road Salting. No salting of the mine road occurs within the permit area. This impact is not a significant concern.

Coal Haulage. Coal is hauled over the paved county road from the mine portal area to Interstate Highway 70. Past experience has indicated that approximately one truck load of coal (43 tons) is spilled annually. Residual coal following cleanup of the spill may wash into local streams during a runoff event. Possible impacts to the surface water are increased total suspended solids and turbidity from the fine coal particulates. The probability of a spill occurring in an area sufficiently close to a stream channel to introduce coal to the stream bed is considered small.

In order to minimize fugitive coal dust haulage trucks are either covered or modified to reduce the amount of coal dust blown off the trucks. The impact from fugitive coal dust is therefore considered to be insignificant due to the small amounts lost during haulage in the permit and adjacent areas.

7.2.9 Cumulative Hydrologic Impact Assessment (CHIA)

A Cumulative Hydrologic Impact Assessment to include the permit and adjacent areas is to be prepared by the UDOGM.

(Figure 7-7)

Abandoned Mining Equipment Locations

7.30 Operation Plan

7.3.1 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.

7.3.1.1 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 acidic, toxic, or other harmful infiltration to the groundwater system. Additionally, SUFCO will manage excavations and disturbances to prevent or control discharges of pollutants to the groundwater. SUFCO commits to replace loss of any surface water identified for protection in this M&RP that are impacted by mining at the SUFCO mine.

Surface Water 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 acidic or toxic drainage, prevents, to the extent possible, additional contributions of suspended solids to streamflow outside the permit area, and otherwise prevents water pollution. Additionally, SUFCO will maintain adequate runoff- and sediment-control facilities to protect local surface waters. SUFCO commits to mitigating any material damage resulting from subsiding perennial streams in the lease area as indicated in Chapter 5 of this M&RP. The plan for protection of the perennial streams meets the BLM requirements for protection of their water rights (BLM, 1992).

Sedimentation Pond Sludge Plan. Sludge contained in the sediment ponds will be cleaned from the ponds and temporarily stockpiled upstream of the pond to allow water to drain from the sludge back into the pond. The sludge will be sampled for acid and toxic forming substances prior to be transported to the waste rock disposal site. Sedimentation pond sludge will be incorporated into the fill as described in ~~Part 3.2.6~~ Section 536 of Waste Rock Volume ~~3~~.

7.3.1.2 Water Monitoring

Groundwater Monitoring. Groundwater monitoring is proposed to be conducted in the SUFCO permit and adjacent areas according to the water monitoring plans presented in Tables 7-2 through 7-5A and for the rock waste disposal site in Section 731 ~~4.7.2~~ in Waste Rock Volume ~~3~~ of this M&RP. These tables are based on the studies done by Mayo and Associates (Appendices 7-17 and 7-18) and supersede previous plans.

The location of the monitoring points are presented on Plate 7-3. The location of the monitoring wells for the rock waste disposal site are presented on Map 5A ~~2~~, Waste Rock Volume ~~3~~ of this M&RP. 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.

The monitoring programs provide data that are reviewed and compared to the baseline data. Any significant changes are evaluated to determine their impact on the hydrologic balance. These comparisons have taken the form of reports prepared by Hydrometrics early in the permit term (1978-1987). Results of these evaluations are submitted periodically to the UDOGM. The annual Water Quality Report submitted to the Division contains the monitoring data.

Baseline data collected for the Pines Tract area included performing field surveys to identify existing springs. Additionally, springs identified in the USGS publication "Hydrology and Effects of Mining in the Quitchupah and Pines -Coal Lease Tracts, Central Utah " (Thiros and Cordy, 1991) were searched for and, when found, included in the baseline survey. Those springs identified and found within the Pines Tract in the above referenced publication are labeled on Plate 7-3 with the prefix "GW - ". During the baseline surveys, several springs identified in the publication could not be found as illustrated on the document maps or by using the printed location descriptions. It is assumed the springs that could not be found have a) stopped flowing; b) were miss mapped; or c) were in close proximity to springs found during the baseline surveys but could not be positively identified as USGS located springs and were therefore given new number designations.

Baseline data collected for the Muddy Tract area is located in the "Coal Tract Evaluations on the Manti-La Sal National Forest" report prepared for the Manti-La Sal National Forest by Cirrus Ecological Solutions, LC. Those springs identified and found within the Muddy Tract in the above referenced publication are labeled on Plate 7-3 with the prefix "M- ".

Sampling for the SUFCO Mine and adjacent areas is accomplished in accordance with the schedule outlined on Tables 7-2 through 7-5A. Sampling for the waste rock disposal site is accomplished in accordance with the schedule ~~outlined in Table 4.7.2-1~~ and the parameter list as outlined ~~on Table 4.7.2-2~~ in Chapter 7 of the Waste Rock Volume~~-3~~ of this M&RP. Groundwater monitoring data are submitted to UDOGM by the end of the quarter following sampling. Monitoring data are submitted in an annual summary by March 31 of the subsequent year.

Groundwater monitoring will continue through the mining and post-mining periods until bond release. The monitoring requirements, including the analytical parameters and the sampling frequency may be modified in the future in consultation with the UDOGM if the data demonstrates that such a modification is justified.

Groundwater monitoring wells US-77-7, US-77-8, US-77-9, US-79-9, US-79-10, US-79-12, US-81-1, US-81-2, US-81-3, 89-16-1, 89-16-1W, 89-18-1, 89-20-1, 89-20-2, and 89-21-1 have been removed from the operational monitoring plan and are listed as historic monitoring wells because these are old baseline wells, wells that have been discontinued or wells the water level measurements are not possible due to the collapse or blockage of the casing. These historic monitoring wells will be permanently sealed along with all the operational groundwater monitoring wells during the final reclamation of the mine in accordance with Sections 6.3.1 and 7.4.8.

In addition to gathering ground water samples from seeps and springs at the surface, SUFCO will obtain a ground water sample, if ground water is encountered, in-mine within the proposed 150 acre lease expansion located in T21S, R5E, Section 10. This sample will be taken shortly after the start-up of the longwall and will be age-dated using isotopic analysis methods. After

the longwall advances through approximately 50% of the panel length within the 150 acre lease expansion, a second ground water sample will be obtained from the face and analyzed

TABLE 7-2

Water Monitoring Program

Monitoring Wells	Protocol	Comments
US-80-2	A	Screened in Castlegate Sandstone
US-80-4	B	Screened in Castlegate Sandstone
89-20-2W	A	Screened in Castlegate Sandstone
US-79-13	B	Screened in Blackhawk Formation
US-81-3	A	Screened in Blackhawk Formation
US-81-4	A	Screened in Blackhawk Formation
01-8-1	A	Screened in Blackhawk Formation
Streams		
SUFCO 006	C,2	Upper South Fork Quitchupah Creek
~~SUFCO 006A~~	~~F,1~~	~~Upper South Fork Quitchupah Creek~~
~~SUFCO 006B~~	~~F,1~~	~~Upper South Fork Quitchupah Creek~~
~~SUFCO 006C~~	~~F,1~~	~~Upper South Fork Quitchupah Creek~~
SUFCO 006D	F,1	Upper South Fork Quitchupah Creek
SUFCO 007	C,2	Upper North Fork Quitchupah Creek
SUFCO 041	C,2	Lower Quitchupah Creek
SUFCO 042	C,2	Lower North Fork Quitchupah Creek
SUFCO 046	C,2	Upper Quitchupah Creek
SUFCO 047A	C,2	Lower East Spring Canyon Creek
SUFCO 090	C,1	Upper Box Canyon Creek
Pines 106	C,2	Upper East Fork Box Canyon
Pines 302	C,1	Muddy Creek-Last Water Creek Confluence
Pines 403	C,2	Lower Box Canyon Creek
Pines 405	C,1	Muddy Creek - Box Creek Confluence

Pines 406b*	C,1	Lower Muddy Creek
Pines 407	C,1	Box Canyon Creek
Pines 408	C,1	East Fork Box Canyon Creek
USFS-109	C,1	Upper Main Fork of Box Canyon Creek
Link 001	C,2	Link Canyon Drainage
Link 002	C,2	Link Canyon Drainage
FP-1	G,6	East Fork of Main Fork of Box Canyon
FP-2	G,6	East Fork of East Fork of Box Canyon
M-STR4	C,1	Cowboy Creek
M-STR6	C,1	Top Greens Canyon
U-Mud	C,1	Confluence North & South Fork Muddy

*Monitoring point Pines 406 was moved downstream to the USGS monitoring point in 1999 and renumbered as Pines 406b. The point is located in the NW1/4NE1/4, Sec. 21, T21S. R6E.

TABLE 7-2 (Continued)

Water Monitoring Program

Springs	Protocol	Comments43
SUFCO 001	D,3	Blackhawk Formation
SUFCO 047	D,4	Star Point Sandstone
SUFCO 057A	D,3	North Horn Formation
SUFCO 089	E,3	Castlegate Sandstone
GW-8	D,5	Price River Formation
GW-9	D,5	Price River Formation
GW-13	D,3	North Horn Formation
GW-20	D,5	Castlegate Sandstone
GW-21	D,3	Castlegate Sandstone
Pines 100	D,4	Castlegate Sandstone
Pines 105	D,3	Castlegate Sandstone
Pines 206	D,5	Blackhawk Formation
Pines 209	D,5	Blackhawk Formation
Pines 212	D,5	Blackhawk Formation
Pines 214	D,5	Blackhawk Formation
Pines 218	D,3	Castlegate Sandstone
Pines 303	D,3	Blackhawk Formation
Pines 310	D,7	Castlegate Sandstone
Pines 311	D,7	Castlegate Sandstone
Link Portal-West	D,4	Link Canyon Portal
Link Portal-East	D,4	Link Canyon Portal
M-SP01	D,3	Price River Formation
M-SP02	D,3	Price River Formation
M-SP04	D,3	
M-SP05	D,3	
M-SP06	D,3	
M-SP08	D,3	North Horn Formation
M-SP09	D,3	

M-SP11	D,5	
M-SP12	D,5	
M-SP15	D,3	
M-SP18	D,3	Price River Formation
M-SP19	D,3	
M-SP20	D,3	
M-SP39	D,3	Price River Formation
M-SP40	D,3	
M-SP41	D,3	
M-SP44	D,3	
M-SP45	D,3	
M-SP53	D,3	North Horn Formation
M-SP60	D,3	
M-SP87	D,3	
M-SP103	D,3	
M-SP104	D,3	
M-SP105	D,3	
M-SP106	D,3	

Mud Spring	D,5	Price River Formation
Broad Hollow	D,5	Blackhawk Formation
~~006A Spring~~	~~H,3~~	~~Price River Formation~~
~~Roberts Spring~~	~~H,3~~	~~Price River Formation~~
~~RS-A~~	~~H,3~~	~~Price River Formation~~
~~RS-B~~	~~H,3~~	~~Price River Formation~~

TABLE 7-2 (Continued)

Water Monitoring Program

Springs	Protocol	Comments

Wedge Spring	H,3	Castlegate Sandstone
Amanda Spring	H,3	Castlegate Sandstone
94-113 Seep	H,3	Price River Formation

TABLE 7-3

Field and Laboratory Measurement Protocol

Water level and flow measurements

A	Monitoring well: quarterly water level measurement	
B	Monitoring well: annual water level measurement (3rd quarter)	
C	Stream: quarterly discharge measurements	
D	Spring: quarterly discharge measurements	
E	Spring Pool:	quarterly water level measurement
F	Stream:	Bi-weekly measurements while mining is occurring under the stream in 2013, thereafter quarterly for two years.
G	Stream:	identify perennial portion of stream on or near October 1 of each year.
H	Spring:	Quarterly measurements while mining is occurring under the 2R2S panel stream in 2013, thereafter quarterly for two years.

Water quality

1 Stream: quarterly surface water quality field measurements

2 Stream: quarterly surface water quality operational laboratory measurements

3 Spring: quarterly groundwater quality field measurements

4 Spring: quarterly groundwater quality operational laboratory measurements

5 Spring: groundwater quality operational laboratory measurements quarterly for two (2) years, then reverting to quarterly water quality field measurements

6 Stream: flow measurements only, no water quality samples required.

7 Spring: initially ground water field measurements June 2006 through December 2006 as accessible then quarterly groundwater field measurements thereafter.

TABLE 7-4

Groundwater Operational Water Quality Parameters

FIELD MEASUREMENTS	REPORTED AS
Water Level or Flow	
pH	pH units
Specific Conductivity	µs/cm @ 25°C
Temperature	°C

LABORATORY MEASUREMENTS	
Total dissolved solids	mg/l
Carbonate	mg/l
Bicarbonate	mg/l
Calcium (dissolved)	mg/l
Chloride	mg/l
Iron (total)	mg/l
Iron (dissolved)	mg/l (pH<7 only)
Magnesium (dissolved)	mg/l
Manganese (total)	mg/l
Manganese (dissolved)	mg/l (pH<7 only)
Potassium (dissolved)	mg/l
Sodium (dissolved)	mg/l
Sulfate	mg/l
Cations	meq/l
Anions	meq/l

TABLE 7-5

Surface Water Operational Water Quality Parameters

FIELD MEASUREMENTS	REPORTED AS
Flow	
pH	pH units
Specific Conductivity	µs/cm @ 25°C
Dissolved Oxygen	mg/l
Temperature	°C

LABORATORY MEASUREMENTS	
Total Dissolved Solids	mg/l
Carbonate	mg/l
Bicarbonate	mg/l
Calcium (dissolved)	mg/l
Chloride	mg/l
Iron (total)	mg/l (third quarter only)
Iron (dissolved)	mg/l (pH<7 third quarter only)
Magnesium (dissolved)	mg/l
Manganese (total)	mg/l (third quarter only)
Manganese (dissolved)	mg/l (pH<7 third quarter only)
Potassium (dissolved)	mg/l
Sodium (dissolved)	mg/l
Sulfate	mg/l
Oil and Grease	mg/l
Cations	meq/l
Anions	meq/l

for the same parameters. The results of the analysis and a sample location map will be submitted to the Division.

Total hardness, total alkalinity, dissolved iron, and dissolved manganese were not included in the groundwater operational monitoring plan proposed by Mayo and Associates (Appendicies 7-17 and 7-18). The reasons for excluding these parameters are discussed below:

- Mayo does not believe that total hardness is a necessary parameter in the operational monitoring plan. Total hardness describes the soap-consuming capacity of water, but has very limited value in geochemical studies. This parameter is generally calculated from the milliequivalent concentrations of Ca^{2+} and Mg^{2+}. Because Ca^{2+} and Mg^{2+} are included in the operational monitoring plan, the parameter could be calculated if it were ever necessary to evaluate total hardness.

- Mayo does not believe that total alkalinity should be included in the operational monitoring plan. In the waters of Wasatch Plateau, total alkalinity is almost exclusively the product of bicarbonate and carbonate alkalinity. Both bicarbonate and carbonate alkalinity are included in the operational monitoring plans. Contributions to alkalinity from hydroxide, silicate, borate, and organic ligands are trivial.

- Mayo did not include dissolved iron and dissolved manganese in the operational monitoring plan because iron and manganese do not readily exist in dissolved form in basic (pH>7) waters but exist instead as hydroxide complexes. All waters in the lease area are basic. Measurements of total iron and manganese quantify both the dissolved and complex forms of these elements.

Equipment, structures and other devices used in conjunction with monitoring the quality and quantity of groundwater in the permit and adjacent areas have been installed, maintained, and operated in accordance with accepted procedures. This equipment will be removed or properly abandoned by SUFCO when no longer needed.

Surface Water Monitoring. Surface water monitoring is conducted in the SUFCO Mine permit and adjacent areas based upon the monitoring plans contained in Tables 7-2 through 7-6. Surface water monitoring locations are identified in Plate 7-3. 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. These tables are based on studies done by Mayo (Appendices 7-17 and 7-18) and supersede previous plans. For clarification of the apparent discrepancies over the classification of stream-monitoring site 047A in the M&RP and the Mayo report (Appendix 7-17) which identified site 047A as a spring-monitoring site. SUFCO has always called the station a surface water monitoring site because samples are taken in a drainage. However, Mayo called this site a spring in their report and recommended monitoring plan. When Mayo first collected samples from the site, they were surprised to learn that water from this site had essentially no tritium. Modern surface waters contain abundant tritium. They visited this site again in June 1996 and located several springs in the drainage several hundred feet above where samples are collected and classified the site as a spring-monitoring site. Nevertheless, Mayo now agrees with SUFCO that this site should be considered a surface water site for monitoring purposes because, at times, this drainage has flow which is contributed by snow melt, precipitation, or sediment pond discharge.

Monitoring sites are sampled three times per year. Surface water monitoring data are submitted to UDOGM by the end of the quarter following sampling. Monitoring data are submitted in an annual summary by March 31 of the subsequent year. UPDES reporting requirements will be met for the three UPDES discharge sites at the mine (see Appendix 7-7).

To better understand the effects that mining will have, if any, on the stream flows within Box Canyon, surface water monitoring sites Pines-407 and Pines-408 will be monitored for stream flows in gallons per minute once every week during the months of June, July, August, September, and October in 1999. Starting in the year 2000, sites 407 and 408

will be monitored once a month in July, August, September, and October for a five year period. If analysis of the data shows no significant changes during this time period, monitoring at these points will be eliminated from the water monitoring program on Table 7-2. Flow measurements at these two sites will be obtained on the same day. Also, the operator will endeavor to obtain the required samples at least five days after the last precipitation event in the drainage area.

To better understand the effects that mining will have, if any, on the stream flows within the South Fork of Quitchupah, surface water monitoring sites SUFCO 006A and SUFCO 006B will be monitored quarterly starting in 2010 for stream flows in gallons per minute and once every two weeks when accessible while mining is occurring within the 15 degree angle-of-draw of the stream channel. Two additional surface water monitoring sites will be monitored quarterly, SUFCO 006C starting in 2011 and SUFCO 006D starting in 2012. Once mining has been completed within the angle-of draw, the sites will be monitored on a quarterly basis for two years after mining has progressed past the 15 degree angle-of-draw. If analysis of the data shows no significant changes during this time period, monitoring at these points will be eliminated from the water monitoring program on Table 7-2. Flow measurements at these four sites will be obtained on the same day.

Areas identified on Plate 7-3 as FP-1 and FP-2 will be monitored on or near October 1 of each year to determine the extent of perennial stream flow, if any, present in the East Fork of the Main Fork of Box Canyon Creek and the East Fork of the East Fork of Box Canyon Creek, respectively. Stream flows will be obtained a short distance below the point where the streams become perennial and the location will be mapped.

Monitoring points Pines 106 and USFS 109 are located at or near the points which the streams become perennial in the East Fork of Box Canyon Creek and the Main Fork of Box Canyon Creek, respectively. The drainages in the area of these two points will be monitored on or near October 1 of each year to verify and map the location where the streams become perennial. Flows will be obtained at Pines 106 and USFS 109 on or near October 1.

Data gathered from monitoring points Pines 407, Pines 408, FP-1, FP-2, Pines 106, and USFS 109 will be compared with precipitation data collected from the mine site weather station, and any other appropriate nearby station, to aid in determining if there have been any mining-related effects on the perennial flows. The flow data, perennial stream flow maps, and the results of the weather data/flow data comparison will be submitted in the fourth quarter water monitoring report each year.

Surface water monitoring will continue through the mining and post-mining periods until bond release. The monitoring requirements (except those required by UPDES) may be modified in the future in consultation with UDOGM if the data demonstrate that such a modification is justified.

Operational monitoring at surface water monitoring sites 022 and 030 has been discontinued from the monitoring plan since the data collected has demonstrated that no flow has been recorded during the monitoring of these sites from June 1983 to October 1997.

Total hardness, total alkalinity, dissolved iron, and dissolved manganese were not included in the surface water operational monitoring plan proposed by Mayo and Associates (Appendices 7-17 and 7-18). The reasons for excluding these parameters are discussed below:

- Mayo does not believe that total hardness is a necessary parameter in the operational monitoring plan. Total hardness describes the soap-consuming capacity of water, but has very limited value in geochemical studies. This parameter is generally calculated from the milliequivalent concentrations of Ca^{2+} and Mg^{2+}. Because Ca^{2+} and Mg^{2+} are included in the operational monitoring plan, the parameter could be calculated if it were ever necessary to evaluate total hardness.

- Mayo does not believe that total alkalinity should be included in the operational monitoring plan. In the waters of Wasatch Plateau, total alkalinity is almost exclusively the product of bicarbonate and carbonate alkalinity. Both bicarbonate and carbonate alkalinity are included in the operational monitoring plans. Contributions to alkalinity from hydroxide, silicate, borate, and organic ligands are trivial.

- Mayo did not include dissolved iron and dissolved manganese in the operational monitoring plan because iron and manganese do not readily exist in dissolved form in basic (pH>7) waters but exist instead as hydroxide complexes. All waters in the lease area are basic. Measurements of total iron and manganese quantify both the dissolved and complex forms of these elements.

Equipment, structures, and other devices used in conjunction with monitoring the quality and quantity of the surface water in the permit and adjacent areas have been installed, maintained, and operated in accordance with accepted procedures. This equipment will be removed by SUFCO when no longer needed.

Stock Water Ponds

Several stock watering ponds are located in the Pines Tract and Quitchupah Lease area. Surface cracking due to mining related subsidence within the Quitchupah Lease has apparently adversely affected a few of the ponds. Action has been taken by SUFCO in the past to mitigate the damage, including applying bentonitic seals to the pond floors and hauling water for livestock. However, ranchers and State and Federal agencies have erroneously claimed that subsidence has adversely affected several ponds outside of the mining areas. In order to more adequately monitor the effects of mining on the stock watering ponds, SUFCO has been negotiating with DOGM, USFS, and the local rancher's association to create a workable monitoring plan for the ponds that can be agreed upon by all participants. DOGM has taken the lead in this process, and as of May 2000, a plan had not yet been finalized. In the interim, SUFCO commits to visiting the ponds within the Pines Tract and Quitchupah Lease area as soon as they are accessible in the spring of each year (typically late April to early May), photographing the condition of each pond, observe the pond for evidence of cracking, estimate the depth and surface area of water contained in the pond, inspect the immediate drainage area for evidence of surface cracking, note general soil moisture conditions, and note the general condition of the pond. Additional monitoring visits will be made in the late summer (late July to early August) and in the fall (late September to early October) of each year. This information will be kept on file at the mine.

It is assumed a new monitoring plan can be agreed upon by the State, USFS, and rancher's association and will be in place prior to the end of 2000. This plan will include the afore mentioned monitoring efforts, as well as determining the functionality and water holding capacity of each potentially affected pond and the determination of the water shed area for each pond. Mitigation requirements in the event of proven mine related effects will also be agreed upon as part of the new monitoring plan.

East Fork of Box Canyon Monitoring and Mitigation Plan

Sufco anticipates undermining and subsiding a portion of the East Fork of Box Canyon beginning in November of 2003 when the mine starts longwalling panel 3LPE. Additional subsidence under the East Fork will occur when the 4LPE panel is mined in 2005. A surface and ground water monitoring and mitigation program more intensive than the general monitoring plan described previously in this Section will be initiated in this area prior to subsidence occurring within the 15-degree angle-of-draw of the stream channel. This monitoring program has included conducting a pre-mining subsidence survey of the East Fork of Box Canyon over the 3LPE and 4LPE panels that incorporated video taping the stream channel from Joe's Mill Ponds downstream to a point above the western-most gate road of the 3LPE panel. The purpose of the video will be to provide a visual record of the stream channel prior to subsidence. Fourteen sites were identified within the portion of the East Fork video taped where the monitoring of surface and/or ground water flows, channel width, channel substrate, vegetation, soils, and general geomorpholgy will occur. The general area in which these sites will be located are illustrated on Figure 7-8.

Stream monitoring sites will be monitored specifically for stream flow, channel width, channel substrate changes, and channel convergence. The geology of spring sources will be identified and described. The substrate of the spring tributary where water discharged from the spring converges with other flows and forms a tributary to the East Fork creek will be described. The width of the spring tributary at the location where the vegetation survey is conducted will be monitored.

Some of the site locations have been identified using a survey grade GPS. However, the locations of sites deeper in the Canyon could not be located with a GPS due to the restrictive nature of the narrow canyon when trying to locate satellites with which to triangulate a location. The vegetation and soil monitoring program is discussed in greater detail in Section 3.2.2.2 of this M&RP. The surface and/or ground water flows and channel width at these stations will be monitored on a weekly basis while mining is occurring within the 15 degree angle-of-draw of the stream channel. Once mining has been completed within the angle-of draw, the sites will be monitored once every two weeks for a period of eight weeks after mining has progressed past the 15 degree angle-of-draw. Table 7-5A presents the monitoring site numbers, monitoring parameters, and the frequency of monitoring. The fourth quarter 2003 water monitoring will be conducted prior to mining within the area of concern in the East Fork of Box Canyon. If new springs are created as a result of subsiding the East Fork, the spring flows will be monitored two times per week until the 15 degree angle-of-draw area above the longwall face has advanced beyond the new spring. Thereafter, the spring flows will be monitored once every week for a period of eight weeks followed by monitoring the springs once every two weeks for eight weeks. A report on the impacts, if any, to the stream or ground water flows, vegetation, soils, general geomorphology, location of the longwall, etc., will be provided via e-mail to the Division on a weekly basis.

One goal of monitoring the stream sites in the East Fork of Box Canyon Creek will be to determine the portion of the stream that is perennial and where the stream is gaining or losing flow prior to, during, and after subsidence. In addition to the monitoring stations, the Thalweg of the stream channel between the lower-most monitoring station and Upper Joe's Mill pond will be surveyed. Also, two pools near monitoring sites EFB-9 and EFB-11, will be monitored before during and after subsidence. The criteria for monitoring the two pools will be width and depth of the pool and the height of the fall structure.

Monitoring for subsidence cracks within the stream channel of the East Fork of Box Canyon Creek will also be part of this intensive monitoring and mitigation plan. The details of the mitigation plan are discussed in greater detail in Section 5.2.5.1 of this M&RP. However, in an effort to compile as much of the monitoring requirements for the East Fork of Box Canyon in a single location within the M&RP, the parameters and frequency of monitoring for subsidence have been included in Table 7-5A. The subsidence monitoring program will consist of inspecting the stream channel floor within the active 15 degree angle-of-draw on a twice-a-week basis. Mining induced subsidence effects, such as cracks, slumps, offsets, etc., will be identified, mapped, and a brief narrative of the effects will be recorded and forwarded to the Division on a weekly basis. The portions of the stream within the active angle-of-draw will also be measured weekly for stream flow and channel convergence. The portions of the channel where the longwall shear has moved beyond the 15 degree angle-of-draw will then be monitored for subsidence effects, flow, and channel convergence on a once every two weeks basis for a period of eight weeks. Following the eight week period, monitoring will be conducted on a quarterly basis for a two year period after no subsidence, interception of water, or diversions of water are identified. This monitoring program will result in a moving zone of "high intensity" or twice a week channel monitoring occurring within an area defined by the 15 degree angle-of-draw above the active longwall face. As the longwall face advances, the "high intensity" zone advances and is followed by the "moderate intensity" once-a-week monitoring zone for eight weeks that is then followed by the "less intense" once every two week monitoring zone. A weekly report will be provided via e-mail to the Division on the results of the subsidence monitoring and mitigation activities. A summary report to the Division documenting

(Figure 7-8)

East Fork Box Monitoring Locations

TABLE 7-5A

East Fork of Box Canyon Monitoring and Mitigation

Monitoring Sites		Protocol / Comments
EFB -1	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -2	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -3	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -4	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -5	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -6	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -7	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -8	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -9	A, C	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -10	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -11	A, C	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -12	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -13	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB -14	A	Monitor flows, vegetation, soils, geomorphology, etc.
EFB-***	B	Subsidence Feature - Monitor location, type, frequency, repairs, etc.

*** Site numbers and quantity of sites will be dependant upon the number of features created due to subsidence. The weekly report to the Division will include all identified sites once mining begins in the area.

the pre- and post-mining conditions of springs and stream channel will be submitted 90 days after subsidence monitoring is complete for the 3LPE and 4LPE panels. This report will include a description of all activities and work conducted by Sufco for stream channel evaluation and mitigation. All identified impacts and mitigation efforts will be documented. The results of mitigation, if performed, will be discussed.

Protocol

A Monitor sites for flow and channel width weekly while site is within the 15 degree angle of draw of the longwall face. Once area is outside angle of draw, monitor on a once every two week basis for eight weeks. Note any changes due to mine-induced subsidence to flows, soils, vegetation, geomorphology, etc. and provide a weekly report via e-mail to the Division of Oil, Gas and Mining. Spring sites will be measured for changes in the substrate conditions and width of spring tributary channel in area of vegetation study will be monitored.

B Monitor subsidence features, such as cracks, and repairs (if needed) on twice a week basis while features are within the 15 degree angle-of-draw of the active longwall face. These sites will be monitored for location, type of subsidence feature, frequency, repairs needed, type of repairs, and success of repairs. After the features are outside the angle-of-draw, monitor features on a weekly basis for eight weeks followed by monitoring of the features once every two weeks for an eight week period and then once quarterly for a two year period after observed subsidence effects are no longer active. Provide a weekly report via e-mail to the Division of Oil, Gas and Mining.

C Monitor fall structures closely associated with these stream sites. The related pool will be monitored for width and depth while the fall structure will be monitored for changes in height.

A rain and temperature monitoring station will be established in the area of the East Fork of Box Canyon as soon as permitting allows. The data collected from the station will be used in combination with data collected from local water monitoring stations to aid in determining what, if any, impacts have occurred to surface runoff, stream flows, and local springs as a result of mining activities.

Prior to implementation of any mining-induced subsidence mitigation efforts in the stream channel as described in Chapter 5, a Stream Alteration Permit will be obtained from the Utah Division of Water Rights. Sufco will have the alteration permit(s) prior to undermining the East Fork stream channel since the mitigation efforts will occur as soon as possible after a need for mitigation is determined.

Every reasonable attempt will be made by Sufco to implement and follow the monitoring program schedule. However, mining of 3LP panel under the East Fork of Box Canyon will begin in the late fall of 2003 and continue through early winter of 2003 and 2004. If access is limited due to snow or inclement weather, the mine's effort to access the area will be documented in the weekly report to the Division. The time of the access attempt, weather conditions, and reason(s) for failing to monitor the East Fork sites will be provided in the report.

A copy of the October 2003 "Monitoring and Mitigation Plan for Mining Under the East Fork of Box Canyon" prepared by the Division and reviewed and accepted by the Forest with some modifications has been included in Appendix 3-10. The preceding paragraphs have been prepared based on this plan. Sufco will meet all of the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the East Fork of Box Canyon.

Springs Pines 310 and Pines 311, located in the east fork (North Water Fork) of the East Fork of Box Canyon, were added to the water monitoring list in July 2006. Initially, these springs have been monitored monthly since June 2006 and will continue to be monitored monthly through December 2006, or as accessible, for field water quality parameters and flow. After December 2006, these sites will be monitored on a quarterly basis for field water quality and flow. The flow from Pines 310 spring area is measured at a point where the majority of the spring area flow coalesce into a channel a few hundred feet north and west of the initial spring discharge area. Field water quality parameters are monitored at one of the points where ground water is discharging from the Castlegate Sandstone. Pines 311 is monitored at the western most point of where ground water is discharging from the outcrop in this spring area.

Pines 105, Joes Mill Pond, Pines 310, and Pines 311 Investigation

The Pines 105 and Joes Mill Pond springs were undermined during the winter of 2005-2006 as Sufco extracted coal from panel 5LPE. In the spring of 2006, Sufco discovered surface discharge of ground water at these locations appeared to have ceased as the area was subsided. The Division concluded that Sufco had caused material damage to the spring areas and required the mine to prepare and submit a plan to restore the spring areas. Initially, Sufco hauled sufficient water to livestock in the area to replace that which was lost when the springs stopped flowing at the surface. In July, Sufco submitted a plan to investigate the effected spring areas and a copy of the investigation plan is included in Appendix 7-22.

The purpose of the investigation proposed is three-fold:

1. Determine if ground water discharge in the area of Pines 105 and Joes Mill Pond springs continue to discharge to the alluvium;
2. Monitor and evaluate the effects of mining on the surface and subsurface water in the Pines 310 and Pines 311 spring areas; and
3. Determine the potential for completing and operating ground water wells in the spring areas as part of the spring site mitigation activities.

The piezometers/wells completed as part of this project will be monitored on a bi-weekly basis through December 2006 or as accessible. Transducers with data loggers will be placed in several of the piezometers to record data on a more continuous basis. The monitoring frequency of the piezometers/wells after December 2006 will be dependant upon the results of the drilling investigation and the impacts to springs Pines 310, 311, 105, and the Joes Mill Pond of mining the 6LPE panel in the fall and winter of 2006.

A report detailing the results of the drilling and piezometer/ well installation and completion will be submitted to the Division by the end of October 2006. Water level data collected from the piezometers/wells will be reported to the Division electronically within two weeks at the end of each the month through December 2006. The Division will also be notified within three days via e-mail or telephone of significant changes to ground water elevations in Pines 310, 311, 105 spring areas as the 6LPE longwall panel is mined. A report compiling the water level data and interpretation of the data will be submitted to the Division by the end of January 2007.

Based on the findings of the investigation, Sufco will submit to the Division either additional plans (if water is not found in the Pines 105 and Joes Mill Pond area, additional bedrock drilling may be required to locate a suitable source of ground water) or a final plan for mitigation of the effected spring areas.

<u>South Fork of Quitchupah 2R2S Block "A" and 3R2S Block "B" Monitoring and Mitigation Plan</u>
A monitoring and mitigation plan that is more intensive than the general Mining and Reclamation Plan area has been proposed for monitoring water flows, subsidence cracks, and repair of the cracks in the portions of the South Fork of Quitchupah channel to be undermined. This plan is outlined below.

Prior to the initiation of undermining and subsidence, a pre-subsidence survey of the stream channel will be conducted in the portion of South Fork of Quitchupah that flows over the 2R2S Block "A" panel and associated gate roads. The survey will consist of a gain/loss survey of flow within the stream channel paying particular attention to surface flows and ground water discharge, soil conditions, and the general channel geomorphology. A similar study was performed in the past but all stream measurements were not conducted on the same date. The second gain/loss survey will be completed on a single day at or near base flow conditions late in the summer or early fall of 2011. The mine will attempt, as part of this second survey, to occupy the same monitoring sites in the panel area as those chosen in the initial survey.

Two weeks before and then once every two weeks after subsidence mining begins, the measuring locations occupied during the gain/loss survey will be reoccupied and flow measurements of the stream flow will be obtained. The approximate locations of these sites are illustrated on Figure 7-9. The once every other week flow measurements will be supplemented by visual observations of flow performed twice a week or once every three to four days. Flow/no flow conditions will be described on these days. If no flow or diminished flows are noted, the appropriate mine and Forest personnel will be contacted and the mitigation plan to restore flows will be implemented.

Semi-weekly flow observations and visual inspections will continue for at least 12 weeks, or as conditions allow, after the completion of mining under the stream channel. The bi-weekly (once every two weeks) stream flow monitoring will continue for at least four weeks, or as conditions and monitoring results indicate necessary, after the completion of subsidence mining under the stream channel. The monitoring plan will then change to quarterly flow and field parameter measurements for two years at four sites: one upstream of the panel, one within the panel, and two downstream of the panel. The location of these new temporary monitoring sites are listed in Table 7-2 and shown on Plate 7-3 and labeled as sites 006A, 006B, 006C and 006D. Additional flow monitoring may be needed to determine specific locations where flow is being lost, and treatments are needed.

Mining ceased beneath the South Fork of Quitchupah Creek in March 2015 (Panel 3R2S) and per the mitigation plan the weekly monitoring obligation for the ponds, springs and channel upstream of the culvert road crossing ceased on June 30, 2016. Both a study of the riparian vegetation and flow data (DOGM database) have provided justification for discontinuing the monitoring. The channel, riparian vegetation and springs appear to be stable and unaffected by subsidence associated with underground mining. Ponds 94-1394, 94-982 and 94-115 have shown no effect from mining in the area of the South Fork of Quitchupah and therefore monitoring was discontinued on July 10, 2016. Weekly water monitoring will continue from the culvert road crossing downstream to the confluence of the North and South Fork of Quitchupah Creek, as will the search for and repair of mining-induced subsidence damage.

The subsidence monitoring plan for the South Fork of Quitchupah will include frequent inspection of the stream channel during and after active subsidence. While mining is occurring under the stream channel, and within the 15-degree angle-of-draw above the active longwall face, that area of the channel will be inspected semi-weekly for subsidence cracks or other related features. As the longwall face advances and the 15-degree angle-of-draw area follows, the portions of the channel that now lie outside the 15-degree angle-of-draw will be monitored for subsidence features on a quarterly basis for two years following the cessation of subsidence related effects, if any, due to mining.

Mitigation of cracks that interrupt or divert flows from the stream channel will be sealed immediately with an appropriate impermeable grout or, in some cases, native materials. Sufco will attempt to seal cracks with the least intrusive methods (typically hand placement of grout or native materials) first. The sealing material may be placed by pouring it directly into the crack or, if cracks occur in an actively flowing portion of the stream, the stream may be temporarily diverted using native materials (or a designed flume if necessary to maintain the flow) until the crack is sealed. If cracks are present in channel walls defined by soil, the soil cracks may be hand filled using a native soil/bentonite mix. The sealing of the channel floor and walls will be accomplished with hand tools such as shovel, picks, trowels, etc.

As a backup plan, in the unlikely event that cracks too large to be sealed through the efforts of one or two persons in one day do occur and it appears there is a danger of water being diverted from the channel for an extended period of time, the stream will be temporarily diverted using native materials and a pipe to carry the flow over the crack to maintain the channel flow. Arrangements will be made to get a contractor to the site as soon as possible to repair the crack after consultation with the Forest Service.

There may be sections of the stream channel that may require more intensive mitigation efforts to restore surface flows in the creek. These efforts could include the drilling of closely spaced shallow boreholes in and adjacent to the stream channel and the injection of an acceptable impermeable grout into the alluvium or bedrock. The work will be accomplished either using hand tools or low impact equipment to minimize surface disturbance. Existing roads and turnouts will be used as staging areas to locate larger equipment and supplies. Any hoses or lines will be transported from the staging areas to the nearby work sites either by hand, the use of pack animals, or by helicopter. This work will be done with a contractor selected after consultation with the Forest Service.

Additionally, it may be required to remove loose rock from the channel floor, either where the channel flows across thin-bedded bedrock or where large rock have fallen into the channel and is impeding flows. In the instance of the former, past experience has shown this can occur in the upper Blackhawk Formation and is easily repaired by removing enough of the broken channel surface to again expose the stream flow. In the instance of the later, removal of large rocks could be accomplished by drilling and then fracturing the rock into smaller fragments more easily moved to locations were they are not impeding flow. This work may be completed using available pneumatic or hydraulic tools that do not require road or pad building disturbances. In the unlikely event that large boulders do need to be moved, pumps and tanks necessary to complete the work will be located in pre-disturbed areas, such as roads or turnouts, and hoses will be walked into the work area.

Sufco will conduct longwall mining operations in such a manner as to minimize surface disturbance while mining within the 15-degree angle-of-draw area that includes the South Fork stream channel. This will be accomplished by advancing the longwall on a schedule where mining will not be suspended for a period to exceed 48 hours.

A copy of the "Monitoring and Mitigation Plan for Undermining the South Fork of Quitchupah 2R2S Block "A" and 3R2S Block "B"has been included in Appendix 3-14. The preceding paragraphs have been prepared based on this plan. Sufco will attempt to meet ~~all of~~ the monitoring and mitigation responsibilities described in the plan as it pertains to the undermining of the South Fork of Quitchupah 2R2S Block "A" and 3R2S Block "B". Refer to Chapter 3, Section 3.3.3.3 for additional information.

A bi-weekly (once every two weeks) report on the impacts to stream flow and required mitigation, if any, will be submitted via e-mail to the Division and the Forest detailing the results of the inspections while mining is occurring under the stream channel. The reports will include, but not necessarily be limited to: a map illustrating the current location of the longwall face;

descriptions and dates of field activities; noted changes in stream and local geomorphology; location, width, frequency of cracks; and a description of repairs, if any, conducted. If the prescribed inspections cannot be conducted,

the reason for the missed inspection and a record of the attempt to conduct the inspection will be submitted to Division and the Forest in the report. Division and the Forest will be notified immediately after mining-induced cracks, if any, are found in the South Fork stream channel and the steps taken or planned to be taken as mitigation. Thereafter, Division and the Forest will be advised of continuing mitigation efforts, if needed, in the report.

Prior to implementation of any mining-induced subsidence mitigation efforts in the stream channel as described in Chapter 5, a Stream Alteration Permit will be obtained from the Utah Division of Water Rights. Sufco will have the alteration permit(s) prior to undermining the South Fork of Quitchupah stream channel since the mitigation efforts will occur as soon as possible after a need for mitigation is determined.

7.3.1.3 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 7.2.8.3). Parameters defining acid- and toxic-forming materials continue to be monitored as described in the Waste Rock Volume ~~3~~ of this M&RP. In the event that 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 the Waste Rock Volume ~~3~~ of this M&RP.

7.3.1.4 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. SUFCO 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.

7.3.1.5 Discharges

Three UPDES discharges are associated with the SUFCO mine. These include two mine water discharges and the sedimentation pond discharge. A description of these discharges is provided in Section 7.2.4.2.

The primary mine-water discharge consists of water from the underground mine workings that is diverted into mined-out areas now used as sumps. These sumps are used to settle out fines before 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. The clarified water flows through a box weir and pipeline to a point on an outcrop of Star Point Sandstone about 20 feet above the North Fork of Quitchupah Creek (see Plate 7-3). From there, the water flows directly into the creek. This discharge water is monitored for compliance with the UPDES permit standards prior to release from the mine.

(Figure 7-9)

Monitoring Stations in the South Fork of Quitchupah Creek Area

An emergency mine-water discharge is also maintained. A description of this discharge point is provided in Section 7.2.4.2.

Water from the disturbed surface area in East Spring Canyon is collected and conveyed to the sedimentation pond. After the collected water is allowed time to settle-out the sediment, the water is discharged to the creek. The discharge water is monitored for compliance with the UPDES permit standards prior to release from the sedimentation pond.

No discharges of surface water are being made to underground mines and none are planned in the future.

Upon abandonment of the mining area, the connection between the Sufco Mine and old Link Canyon Mine works will be sealed and made as water tight as possible. A low area that will capture water will remain in the west portal, in the same area as the roof fall that created the underground pond prior to rehabilitating the old Link Canyon Mine portal. The low area will be allowed to fill and will discharge naturally at the west portal. Some structures used to seal the old works from the rehabilitated works may be removed as the mine is abandoned thus ensuring the discharge at the east portal during reclamation.

7.3.1.6 Stream Buffer Zones

All perennial and intermittent streams in the mine area are protected by 100 foot stream buffer zones on either side of these streams. Coal mining and reclamation operations should not cause or contribute to the violation of applicable Utah or federal water standards and should not adversely effect the water quantity and quality or other environmental resources of the stream.

Stream Channel Diversions. Temporary or permanent stream channel diversions comply with R645-301-742.300.

Buffer Zone Designation. The areas surrounding the streams that are not to be disturbed are designated as buffer zones, and SUFCO has marked these as specified in R645-301-521.260.

7.3.1.7 Cross Sections 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 7-2. Discharges associated with the permit and adjacent areas are located as presented on Plate 7-3.

The locations of each water diversion, collection, conveyance, treatment, storage, and discharge facility to be used in the East Spring Canyon area are presented on Plate 7-6. Similar information for the waste-rock disposal site is presented in the Waste Rock Volume ~~3~~ of this M&RP. Similar information for the Link Canyon Substation No. 1 and No. 2 facility areas is presented on Plates 5-2D and 5-2E. Similar information for the Link Canyon Portal facility area is presented on Plate 5-2F.
Locations and elevations of each station to be used for water monitoring during coal mining and reclamation operations are presented on Plate 7-3.

The construction details and cross sections for the concrete sediment trap are located in the "Alternate #1 Drainage Facilities and Sediment Control Plan" (Appendix 7-8). The existing topography and cross sections for the primary sedimentation pond are located on Plates 7-4 and 7-5. The design topography and cross sections for the overflow pond are located on Plates 7-4A and 7-5A. The design topography and cross sections for the waste rock disposal site sedimentation pond are located in the Waste Rock Volume ~~3~~ of this M&RP.

Other Cross Sections and Maps. Other relevant cross sections or maps are presented and discussed in Chapter 5 of this M&RP.

7.3.1.8 Water Rights and Replacement

Ground and surface water rights do exist within the Sufco Mine lease area. Mitigation has been performed at stock pond locations where claims have been made that the available surface water has been impacted by subsidence. Mitigation at these locations has been performed by the placement of bentonite in the bottom of stock ponds and by hauling replacement water to the ponds for livestock use during summer months.

The Permittee will mitigate and replace the water supply of any land owner or adversely affected State appropriated water if such a water supply proves to be contaminated, diminished or interrupted as a result of mining operations. First, a determination will be made by the Division in accordance with R645-301-731.800 as to whether or not material damage has occurred. Then, in accordance with Regulation R645-301-525.510, the operator will correct any material damage resulting from subsidence caused to surface lands (which includes water rights), to the extent technologically and economically feasible. Negotiations will be held immediately with the impacted party to determine the appropriate mitigation activities. 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 (i.e., stream floors on bed rock or in shallow alluvium), and; construction of a ground water well and the installation of pumps to restore flows. If the above efforts are not successful, then the operator 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 water supply in the East Fork of Box Canyon is of special concern to Sufco and the regulatory authorities. In an effort to protect the minimal surface flows in this area, an intense monitoring and mitigation plan will be implemented prior to full extraction mining taking place under the East Fork. If changes in the quantity and quality of the water in the East Fork are noted, the Division will be immediately notified. A determination of the amount of water, if any, that is lost due to mining activities will be made using surface and ground water flow and climatic data. If a loss of flow is confirmed, the loss will be addressed as described in the proceeding text of this section.

The Forest Service (USFS) continues to work with the Division of Water Rights to develop subbasin claims that would assert a claim of right for all developed and undeveloped water on the National Forest System lands. The majority of the water rights (65) in the tract belong to the USFS for stockwatering along streams and at springs. The permittee holds five water rights for multiple uses including temporary water mitigation and exploratory drilling.

7.3.2 Sediment Control Measures

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.

7.3.2.1 Siltation Structures

The siltation structures within the permit area consist of the sedimentation ponds described in Section 7.3.2.2.

7.3.2.2 Sedimentation Ponds

There are four sedimentation ponds operating at the mine facility. Three of them are located in the immediate vicinity of the existing facilities. A fourth pond is located at the waste rock disposal site.

Concrete Sediment Trap. A sediment trap is located near the southern end of the mine yard which captures all disturbed area runoff from the mine yard area. This concrete sediment trap was designed to remove in excess of 65% of all solids from the disturbed area runoff before the water enters the main sedimentation pond below. The purpose of the concrete sediment trap is to reduce the required size of the main sedimentation pond and to decrease the amount of overall disturbance. A detailed design of the concrete sediment trap is contained in Appendix 7-8.

Operation of the sediment trap includes decanting the existing water and removing the sediment. Except during use, the telescoping decanting valve on the trap is locked to prevent unauthorized drainage of the concrete structure. On regular UPDES sampling days, the structure is inspected for sediment content. If a sediment delta is evident at the water level extending to or beyond the first of the mine discharge pipes, the structure will be decanted within one week of the observation. The decanting period shall not exceed four days. Sediment material from the structure will then be removed with a front-end loader and disposed of at the waste-rock disposal site.

Primary Sedimentation Pond. The primary sedimentation pond is located in the area immediately below the fill on which the existing mine facilities are constructed. The existing sedimentation pond topography and cross sections are presented on Plates 7-4 and 7-5 of this M&RP.

The staff gauge in the pond has been marked to indicate the 60% clean-out elevation of 7408.1 feet as defined in Section 7.4.2. At least once each year following the spring runoff event, the pond will be drained with the decanting device to inspect the accumulated sediment level. The pond will be sampled for effluent quality immediately before the decanting operation.

If sediment has accumulated to the 60% clean-out elevation, the pond will be cleaned. The sediment will be transported and disposed of at the waste rock disposal site.

The southern-most extent of the sedimentation pond dam is located 180 feet south of the lease boundary across East Spring Canyon. The Fishlake National Forest Service issued a special use permit that approved the construction with the stipulation that the dam site be included in the disturbed mine permit area and subject to final reclamation. The area is included in the calculation of the disturbed area subject to bonding and in the calculation of final reclamation costs.

Overflow Pond. The overflow pond is located 800 feet downstream of the primary sedimentation pond. The overflow pond topography, cross sections and details are presented on Plate 7-4A and 7-5A of this M&RP.

The staff gauge in the overflow pond will be marked to indicate a clean-out elevation of 7243.62 feet as defined in Section 7.4.2. At least once each year, following the spring runoff event, the pond will be drained with the decanting device to inspect the accumulated sediment level. The pond will be sampled for effluent quality immediately before the decanting operation. When sediment has accumulated to the clean-out elevation, the pond will be cleaned. The sediment will be transported and disposed of at the waste rock disposal site.

Waste Rock Disposal Site Sedimentation Pond. The sedimentation pond located at the waste rock disposal site is presented on ~~Figures 1 and 1A of Volume 3~~ Map 7 in the Waste Rock Volume of this M&RP. A discussion of the operation, maintenance, and reclamation of this pond is also contained therein.

Compliance Requirements. All sedimentation ponds will be maintained until removal in accordance with the reclamation plan (see Section 5.40 of this M&RP). When a pond is removed, the land will be revegetated in accordance with the reclamation plan defined in Section 5.40.

The Primary sedimentation pond and concrete sediment trap were designed together to contain the volume of sediment equal to 0.035 acre-foot per acre of disturbed area. The concrete sediment trap will provide for removal of 65% of this sediment volume, while the sedimentation pond will contain the remaining 35%. In addition, the sedimentation pond will fully contain the runoff from the 10-year, 24-hour storm event. The spillways for both the sedimentation pond and concrete sediment trap will adequately pass the peak flow from the 25-year, 6-hour precipitation event.

The overflow pond has been designed to retain sediment from the disturbed mine facilities and runoff from the 10-year, 24-hour storm event. The spillway for the overflow pond has been designed to safely pass the peak flow from the 25-year, 6-hour precipitation event. The affected area will be included in the calculation of the disturbed area subject to bonding and in the calculation of final reclamation costs.

The waste rock disposal site sedimentation pond was designed to contain a sediment volume equal to 0.1 acre-foot per acre of disturbed area. It will also fully contain the runoff from the 10-year, 24-hour storm event. The spillways for the pond were initially designed to pass the peak flows from the 25-year, 24-hour storm event. The revised design storm (25-year, 6-hour precipitation event) results in a smaller peak discharge and, thus, the spillways are adequately designed.

Additional design standards for all ponds are presented in Section 7.4.2.

MSHA Requirements. MSHA requirements defined in 30 CFR 77.216 are not applicable since the existing sedimentation 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 than 20 acre-feet.

7.3.2.3 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 run-off to by-pass the disturbed area via a network of culverts.
- Routing run-off from the undisturbed east slope above the facilities down diversion ditches in the east side road to by-pass the disturbed area.
- Routing of any run-off from undisturbed areas which enters the disturbed area into the sediment control system.

The location of each diversion ditch or culvert for the main facility area is presented on Plate 7-6. The location of each diversion ditch for the Link Canyon Portal and Substation No. 1 and No. 2 facility areas is presented on Plates 5-2D, 5-2E, and 5-2F. A brief list of each diversion structure is as follows (refer to Plates 7-6, 5-2D, 5-2E, and 5-2F for the location of each sub-watershed boundary):

Diversion Ditches:

- Interception ditch along the East Side Road which drains watershed CBE-5.
- Interception ditch along the East Side Road which drains watersheds CBE-1 through CBE-5.
- Substation pad upper undisturbed interception ditch which drains watershed CBE-4.
- Substation pad lower undisturbed interception ditch which drains watershed CBE-3. This ditch is part of the alternate sediment control measures defined in Section 7.4.2.1.
- Riprap diversion channel for CBE continuance diversion. This diversion drains watersheds CBE-1 through CBE-5.
- Interception ditch which drains undisturbed watershed ESC-6 north of ATOF.
- Interception ditch which drains undisturbed watershed ESC-7 north of ATOF.
- Interception ditch which drains undisturbed watershed MSH-2 north of ATOF.
- Sedimentation Pond access road diversion ditch which drains disturbed watershed DIS-3.

- Main access road diversion ditch which drains undisturbed watershed DWN-1.

- Link Canyon Substation No. 1 ditch which drains watersheds LINK and ASCA-1.

- Link Canyon Substation No. 1 road swell which drains watersheds LINK, ASCA-1, and ASCA-3.

- Link Canyon Substation No. 2 ditch which drains watersheds LINK No.2, ASCA-4, and ASCA-7.

- Link Canyon Portal Access Road Channel No. 1 which diverts the access road disturbed drainage and undisturbed drainage above the access road to the Link Canyon drainage bypass culvert inlet.

- Link Canyon Portal Pad Channel No. 2 which diverts the pad area disturbed drainage and the undisturbed area above the pad to the Link Canyon drainage bypass culvert inlet.

- West Overflow Pond Undisturbed Area Diversion Channel which diverts and drains runoff from watershed DWN-3 around to Overflow Pond Access Road Channel.

- Overflow Pond Access Road Channel which diverts and drains runoff from watershed DWN-3 along the Overflow Pond Access Road.

- East Overflow Pond Undisturbed Area Diversion Channel (Shallow Section) which diverts and drains runoff from watershed DWN-5 around the Overflow Pond.

- East Overflow Pond Undisturbed Area Diversion Channel (Steep Section) which diverts and drains runoff from watershed DWN-5 down the overflow pond impoundment.

Diversion Culverts:

- CBE bypass culvert at substation which drains watersheds CBE-2 through CBE-5.

- Pipe No. 5 diversion culvert which drains undisturbed watershed DWN-1.

- Mud Spring Hollow bypass culvert which drains undisturbed watersheds MSH-1 and MSH-2. This culvert discharges into the East Spring Canyon bypass culvert.

- East Spring Canyon bypass culvert which drains undisturbed watersheds ESC-1 through ESC-7. This bypass also receives flows from the Mud Spring Hollow bypass.

- East Spring Canyon bypass culvert emergency diversion at the main mine fan. This 3.5 foot square drop drain with oil skimmer cap connects into a 48-inch culvert directed into the East Spring Canyon bypass culvert. This serves as an overflow system when the trash rack at the inlet to East Spring Canyon becomes plugged with debris.

- 8-inch pipe diversion for undisturbed watershed ESC-7. This pipe tees to the 10-inch pipe that drains undisturbed watershed ESC-6.

- Main Mine Fan Diversion. The main mine fan is located in a depression which is nine feet below the adjacent mine yard drainage system. A sump pump with automatic float controls in front of the main fan will pump the runoff from this area into the 10-inch mine yard drain line.

- 10-inch mine yard culvert drainage system. This system discharges to the concrete sediment trap.

- Link Canyon Portal bypass culvert which drains watersheds LCP-East and LCP-West.

- The primary sediment pond diversion culvert allows runoff from the disturbed area to bypass the primary sedimentation pond, thereby allowing water to be drained from the primary sedimentation pond for sediment removal. This culvert discharges to the overflow pond.

- The 66-inch overflow pond bypass culvert allows runoff from undisturbed watersheds DWN-1, DWN-2, DWN-3, MSH-1, MSH-2, and ESC-1 through ESC-7 to bypass the overflow pond. This culvert discharges immediately downstream of the overflow pond.

All diversion ditches are maintained with adequate rip-rap or alternative erosion protection in the ditch sections where flow velocities are great enough that a ditch lining is necessary. Adequate ditch capacities are maintained in all ditch sections. Culverts are kept free of debris and each outlet is lined with adequate riprap. Detailed diversion design is presented in Section 7.4.2.

Water bars in roadside ditches have been constructed of rocks to form low dams across the ditches. The rocks are large enough to resist movement during anticipated run-off events. They are arranged to channel water down the center of the ditch rather than around the water bar ends to prevent erosion of the ditch side walls. Accumulations of sediment behind the ditch water bars are permitted to rise to the lowest height of the bar.

Diversion ditch and culvert operation and maintenance for the diversions within the waste rock disposal site are presented in the Waste Rock Volume ~~3~~ of this M&RP.

7.3.2.4 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 and Link Canyon facility area are included in the list of diversions presented in Section 7.3.2.3 above. In addition, water bars have been constructed across dirt roads within the disturbed areas to channel water off the road onto downslopes or into roadside ditches. Riprap has been placed along these transitions to minimize the potential for erosion. Water bars have been constructed on the East Side road and along the access road to the sedimentation pond. Additional road drainage design information is presented in Section 7.4.2.

The operation of the road drainage diversions within the waste rock disposal site is presented in the Waste Rock Volume ~~3~~ of this M&RP.

All road drainage diversions will be maintained and repaired to original condition following the occurrence of a large storm event. Culvert inlets and outlets will be kept clear of sediment and other debris.

7.3.3 Impoundments

7.3.3.1 General Plans

There are four sedimentation ponds operating at the mine facility as described in Section 7.3.2.2. Three ponds are located at the East Spring Canyon surface facilities. A fourth pond is located at the waste rock disposal site.

The concrete sediment trap is located near the southern end of the mine yard and captures all disturbed area runoff from the mine yard area. A detailed design of the sediment trap is contained in Appendix 7-8.

The primary sedimentation pond is located in the area immediately below the fill on which the existing mine facilities are constructed. The existing sedimentation pond topography and cross sections are presented on Plates 7-4 and 7-5 of this M&RP.

The overflow pond is located 800 feet downstream from the primary sedimentation pond. The overflow pond is designed to allow for flood control and sediment settling while the primary sediment pond is being drawn down for sediment removal. A series of canal boxes with valves will allow the primary sediment pond to be bypassed for draw down, sediment removal, and maintenance. Detailed design information regarding the overflow pond is provided in Appendix 7-23 and Plates 7-4A and 7-5A.

The waste rock disposal site sedimentation pond is located at the waste rock disposal site and is presented on ~~Figures 1 and 1A of~~ Map 7 in the Waste Rock Volume ~~3~~ of this M&RP.

Certification. All 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.

Maps and Cross Sections. The construction details and cross sections for the concrete sediment trap are located in Appendix 7-8. The existing topography and cross sections for the main sedimentation pond are located on Plates 7-4 and 7-5 of this M&RP. The topography and cross sections for the overflow pond are located on Plates 7-4A and 7-5A of this M&RP. The design topography and cross sections for the waste rock disposal site sedimentation pond are located in the Waste Rock Volume ~~3~~ of this M&RP.

Narrative. A description of each sedimentation pond is presented in Sections 7.3.2.2 and 7.4.2 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 7.2.4 and Chapter 6, respectively.

Design Plans and Construction Schedule. There are no additional structures proposed for the mining operation at this time. Designs of all existing structures have been described within this M&RP.

7.3.3.2 Permanent and Temporary Impoundments

Requirements. All 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. Specific hydrologic design criteria for each impoundment are presented in Section 7.4.3. All impoundments will be inspected regularly based on the schedule contained in Section 5.1.4.3.

Permanent Impoundments. There are no permanent impoundment structures within the mine facilities at this time.

Temporary Impoundments. The UDOGM authorized the construction of the existing temporary impoundments at the mine as 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 on a quarterly basis.

7.3.4 Discharge Structures

The discharge structures within the East Spring Canyon facilities area include the spillways on the concrete sediment trap, primary sedimentation pond, and overflow pond. These discharge structures are defined in Section 7.4.4. The spillways constructed on the waste rock disposal site sedimentation pond are described in the Waste Rock Volume ~~3~~ of this M&RP.

7.3.5 Disposal of Excess Spoil

There is no excess spoil generated at the mine.

7.3.6 Coal Mine Waste

Areas designated for the disposal of coal mine waste and coal mine waste structures are constructed and maintained as described in the Waste Rock Volume ~~3~~ of this M&RP.

7.3.7 Noncoal Mine Waste

Noncoal mine waste is stored and disposed of as described in Chapter 5.

7.3.8 Temporary Casing and Sealing of Wells

Each groundwater monitoring well identified on Plate 7-3 will be operated and maintained as described in Section 7.4.8.

7.40 Design Criteria and Plans

7.4.1 General Requirements

This M&RP includes site-specific plans that incorporate minimum design criteria for the control of drainage from disturbed and undisturbed areas.

7.4.2 Sediment Control Measures

7.4.2.1 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 7.5.1.
- Minimize erosion to the extent possible.

Appendix 5-11 contains design drawings and information pertaining to the paving of an area in the upper mine yard and the repair/re-paving of an adjacent area. The areas to be paved will have three segments of concrete gutter with drip drains/inlet boxes and a fourth drop drain/inlet box in the asphalt to collect and direct runoff to the lower mine yard.

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 (standard seed mix in section 3.4.1.2 minus the shrubs

and trees) to provide interim reclamation and stability of the slopes during mining.

- Provide straw dikes, riprap, check dams, mulches, vegetative sediment filters, dugout ponds and other measures that reduce overland flow velocities, reduce runoff volumes or trap sediment;
- Treatment with chemicals; and
- Treatment of mine drainage in underground sumps. There are four portal sites in Quitchupah Canyon. The 4 East portal site is classified as an ASCA. South portals, 3 East portals, and Quitchupah portals have sediment control consisting of routing runoff from disturbed areas into the mine with berms and insloping. The runoff is then treated using in mine settling ponds prior to discharge through approved UPDES points. The disturbed area associated with the South portals is 0.017 acre. The disturbed area associated with the 3 East portals is 0.017 acre. The disturbed area associated with the Quitchupah portals is 0.017 acre. A calculation demonstrating the insignificance of the inflow of surface water into the mine is included in Appendix 7-16.

During construction of the new overflow pond sediment from the disturbed area will be controlled by the use of containment berms and silt fencing.

Several alternate sediment control areas are defined within the mine site and are listed below (see Plates 5-2B,C,D,E,&F):

- The original substation pad area and fire water tank above the office building. The sediment controls include a graveled pad area and silt fences. The disturbed area is 0.324 acre.

- The topsoil stockpile near the mine site primary sedimentation pond. The sediment control consists of containment berms and silt fencing. The disturbed area is 0.105 acre.

- The topsoil stockpile near the mine site overflow pond. The sediment control consists of containment berms and silt fencing. The disturbed area of the overflow pond topsoil stockpile is 0.141 acres.
- The subsoil, topsoil and sedimentation pond topsoil stockpiles at the waste rock disposal site. The sediment controls include containment berms and silt fencing. The disturbed area of the subsoil and topsoil stockpiles is 1.24 acre. The disturbed area of the pond topsoil pile is 0.293 acre.
- The area above the mine fan in East Spring Canyon. The sediment control consists of silt fencing. The disturbed area is 0.122 acre.
- The pump house in Convulsion Canyon. The sediment control consists of containment berms and silt fencing. The disturbed area is 0.075 acre.
- The leach field in Convulsion Canyon. The sediment control consists of containment berms and silt fencing. The area is fenced to prevent grazing. The disturbed area is 0.40 acre.
- The new substation pad disturbed area is 0.287 acre. The sediment controls include gravel and silt fences.
- The 4 East portal site consists of a pad area where a mine fan has been built. The disturbed area associated with the two portal openings at this site is 0.70 acre. Alternate sediment control at this pad consists of a containment berm, gravel and silt fencing.
- The Link Canyon Substation No. 1 facility disturbed area is 0.18 acre. This substation pad area was reclaimed in 2000. The sediment control consists of containment berms, silt fencing, and vegetation.
- The Link Canyon Substation No. 2 facility disturbed area is 0.12 acre. The sediment control consists of containment berms, gravel and silt fencing.
- The Link Canyon Portal facility disturbed area is 0.18 acre. The sediment control consists of containment berms, gravel and silt fencing.

The total area for Alternate Sediment Control Areas (ASCA) is 4.167 acres. This is approximately 13.6 percent of 30.454 acres of total disturbed area at the mine site, Link

Canyon Portal and Substation No. 1 and No. 2 facility sites, and waste rock disposal site (including ASCA's and SAE's).

7.4.2.2 Siltation Structures

General Requirements. 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.

The existing siltation structures for the main facilities area, the concrete sediment trap and primary sedimentation pond, were not constructed before beginning coal mining operations. The structures were constructed upon implementation of applicable State and Federal Regulations. The overflow pond was constructed to allow for continued compliance with State and Federal Regulations. The sedimentation pond for the waste rock disposal site was constructed before the site was used. Each structure has been certified by a qualified registered professional engineer.

All siltation structures which impound water have been designed, constructed and maintained as described in Chapter 5 and Sections 7.3.3 and 7.4.3.

Siltation structures are also provided at the mine-water discharges points. Water is presently being discharged from the mine at UPDES discharge point 003 from the Quitchupah Canyon breakouts. UPDES discharge point 001 is approved as an alternative mine water discharge point. Design of the siltation structures for these discharge points is presented in Section 7.3.1.5.

Sedimentation Ponds. There are four sedimentation ponds operating within the permit area. These ponds are described as follows:

- Concrete sediment trap located at the south end of the main facilities area.
- Primary sedimentation pond located in the area immediately below the fill on which the existing mine facilities are constructed.

- Overflow pond located approximately 800 feet downstream from the primary sedimentation pond.
- Waste rock disposal site sedimentation pond located at the waste rock disposal site.

Sedimentation Pond Use.

Individually or in Series. The concrete sediment trap and the primary sedimentation pond or overflow pond are designed to work in series to manage the design sediment volume and pass the peak discharge rate. The overflow pond is designed to allow runoff from the concrete sediment trap to bypass the primary sediment pond to allow for draw down, sediment removal, and maintenance. The sedimentation pond at the waste rock disposal site functions individually.

Location. All sedimentation ponds are located as near as possible to the disturbed areas. The location of the concrete sediment trap, primary sedimentation pond, and overflow pond are indicated on Plate 7-6. Location of the waste rock disposal site sedimentation pond is presented in the Waste Rock Volume ~~3~~ of this M&RP. The concrete sediment trap, primary sediment pond, and waste rock disposal site sediment pond are not located within a perennial stream channel. The overflow pond is located within a perennial stream channel.

Design, Construction and Maintenance.

Sediment Storage Volume. The concrete sediment trap, primary sedimentation pond or overflow pond were designed to, in series, control a sediment volume of 0.035 acre-feet per acre of disturbed area. The disturbed area, contributing sediment to the concrete sediment trap and primary sedimentation pond, contains 15.88 acres from contributing watersheds DIS-1 through DIS-5. The disturbed areas, contributing sediment to the overflow pond, contains 16.49 acres from contributing watersheds DIS-1 through DIS-6. Refer to Plate 7-6 for a location of the watersheds. Although it contributes runoff to the ponds, a sediment storage volume from the watershed CBW-1 is not included in the calculations because it is an undisturbed area.

The sediment trap was constructed to provide easy access for the removal of 65% of all solids before runoff from the disturbed area enters the primary sedimentation pond. Although the concrete basin does not have 65% of the total sediment volume it permits reduction of the primary pond size by that amount because it provides a sediment control measure for the removal of sediment equal to the reduced volume.

The concrete sediment trap was constructed after consultation with representatives from the Office of Surface Mining, the Division of Oil, Gas and Mining and the U.S. Forest Service during the spring of 1980 and was built subsequent to approval of the various regulatory authorities. The design was selected in preference to other designs employing a full size pond due to environmental considerations. Among these considerations was that a full size pond would have required the disturbance of at least twelve additional acres of presently undisturbed area. In addition, the resulting pond would have been exceedingly difficult to maintain with respect to regular and frequent sediment recovery and disposal.

The primary sedimentation pond was designed to fully contain the remaining 35% of the design sediment volume. Based on calculations presented in Appendix 7-14, the disturbed area totals 15.88 acres. Therefore, the primary sedimentation pond will contain a maximum of 24,211 cubic feet (0.556 acre-feet) of sediment. The elevation of the maximum sediment level is 7410.4 feet. The 60% sediment clean-out volume of 14,527 cubic feet (0.333 acre-feet) has an elevation of 7408.1 feet.

The overflow pond is designed to work in series with the concrete sediment trap, and/or the primary sedimentation pond. A review of sedimentation pond discharge records for the period of 11/06/99 to 07/09/08 indicates that normal dust suppression activities at the facility, and wash down of transport vehicles contributes a constant flow of approximately 0.046 cfs from the disturbed area to the concrete sediment trap and primary sedimentation pond. The sediment trap and the primary sedimentation pond were designed to create a quiescent sediment settling area capable of containing runoff from a 10-year, 24-hour storm with a spillway capable of safely discharging the peak flow resulting from a 25-year, 6-hour storm. Dust suppression and washdown water flows almost constantly into these two basins, the overflow pond is sized to more efficiently manage runoff from the 10-year, 24-hour storm from the disturbed and adjacent areas.

The overflow pond was designed to fully contain the design sediment volume for the disturbed area. As indicated in Appendix 7-23, the disturbed area associated with this pond totals 16.49 acres. This disturbed area includes 15.88 acres treated and detained by the concrete sediment trap and primary sediment pond and 0.61acres of the overflow pond. The 0.61 acres of disturbed area for the overflow pond includes only the pond area itself no additional sediment will be created. Based on a sediment storage volume of 0.035 acre-feet per acre of disturbed area, the overflow pond will contain 24,211 cubic feet (0.556 acre-feet) of sediment. The elevation of the maximum sediment level is 7,245.41 feet. The 60% sediment clean-out volume of 14,526 cubic feet (0.33 acre-feet) has an elevation of 7,243.62 feet.

The design sediment storage volume and 60% clean-out level for the waste rock disposal site sedimentation pond is presented in the Waste Rock Volume ~~3~~ of this M&RP.

Detention Time. An adequate detention time will be provided in each pond to allow the effluent to meet UPDES and 40 CFR Part 434 limitations. The decant water will be sampled and discharged from the pond in accordance with the above referenced effluent limitations.

Design Event. The sedimentation ponds are designed to fully contain the 10-year, 24-hour precipitation event.

Overflow Pond, Primary Sedimentation Pond and Concrete Sediment Trap. The calculations contained in Appendix 7-14 were based on the assumption that the primary sedimentation pond will fully contain the runoff from the main facility disturbed areas. The concrete sediment trap will pass the water to the sedimentation pond, but will not provide significant runoff storage. The concrete sediment trap is used primarily for the removal of sediment.

Several drainage areas, identified on Plate 7-6, contribute runoff to the overflow pond. The disturbed drainage area contributing directly to the overflow pond are DIS-1 through DIS-6. The undisturbed drainage area contributing to the overflow pond is CBW-1.

The curve numbers used to determine the design runoff volume were based on information presented in Appendix 7-11 and Appendix 7-23. The curve number assumed for the disturbed watershed DIS-1 through DIS-4 is 80 and for DIS-5 and DIS-6 is 100, see Appendix 7-11 and 7-23. The curve number for undisturbed watersheds CBW-1 is 72, see Appendix 7-11. Refer to Table 7-6 for a list of all disturbed and undisturbed subwatershed areas and curve numbers within the facilities area. Based on the curve numbers presented above, the storm runoff volume from the 10-year, 24-hour storm event to the overflow pond is 57,898 cubic feet (1.33 acre-feet). The maintenance runoff rate of 0.046 cfs adds 3,975 cubic feet (0.0913 acre-feet) to this volume during a 24-hour period, resulting in a combined required runoff storage volume of 61,873 cubic feet (1.42 acre-feet) without sediment storage. The calculations, presented in Appendix 7-23, are based on hydrologic design methods described in Appendix 7-10. As presented above, the maximum sediment storage volume is 24,211 cubic feet. In order to fully contain the runoff from the 10-year, 24-hour storm event and the maximum sediment storage, the primary spillway elevation for the overflow pond is 7252.5 (2.14 acre-feet), from the stage-capacity table contained in Table 7-8A. The required minimum elevation for the primary spillway with a volume of 24,211 cubic feet is 7,252.26, for ease of construction the primary spillway elevation will be 7,252.50 feet. The actual overflow pond is 3.15 acre feet.

Several drainage areas, identified on Plate 7-6, contribute runoff to the primary sedimentation pond. The disturbed drainage areas contributing to the pond are DIS-1, DIS-2, DIS-3, DIS-4, and DIS-5. The undisturbed drainage area contributing to the pond is CBW-1. The undisturbed drainage CBW-1 is discharged to the pond because it was determined that construction of a diversion ditch along the top of the cut slope from the trash pit north to Mud Spring Hollow may cause some stability problems with the cut slope.

The curve numbers used to determine the runoff volumes were based on information presented in Appendix 7-9. The average curve number for the disturbed area is 80. The curve number assumed for the undisturbed watershed CBW-1 is 72. The curve number for the pond area (watershed DIS-5) was assumed to be 100. Refer to Table 7-6 for a list of all disturbed and undisturbed subwatershed areas and curve numbers within the facilities area.

Based on the curve numbers presented above, the storm runoff volume from the 10-year, 24-hour storm event is 57,898 cubic feet (1.329 acre-feet). The calculations, presented in Appendix 7-14, are based on hydrologic design methods described in Appendix 7-10. As presented above, the maximum sediment storage volume is 24,211 cubic feet. Thus, the minimum capacity of the pond at the elevation of the primary spillway must be 82,109 cubic feet (1.885 acre-feet), assuming the spillway does not spill during the 10-year, 24-hour storm.

In order to fully contain the runoff from the 10-year, 24-hour storm event and the maximum sediment storage, the primary spillway on the sedimentation pond will need to be raised. From the stage-capacity curve for the existing pond structure contained in Appendix 7-14, the required elevation of the primary spillway is 7418.15 feet.

Waste Rock Disposal Site Sedimentation Pond. The design storm runoff volume for the waste rock disposal site sedimentation pond is presented in the Waste Rock Volume ~~3~~ of this M&RP. The sedimentation pond adequately contains the runoff from the 10-year, 24-hour storm event with maximum sediment storage.

Dewatering Device. The concrete sediment trap contains a telescoping dewatering device which can decant water from any elevation in the basin. It will be locked to prevent unauthorized drainage of the concrete structure.

The existing dewatering device on the primary sedimentation pond will be modified so the flowline will be at the elevation of the maximum sediment level, elevation 7410.4 feet. Water will be discharged from the pond in accordance with UPDES guidelines.

The overflow pond dewatering device is designed to decant at the 60% sediment level, 7,243.62 feet. Water will be discharged from the pond in accordance with UPDES guidelines.

The dewatering device for the waste rock site sedimentation pond is identified in the Waste Rock Volume ~~3~~ of this M&RP.

<u>Short Circuiting.</u> Short circuiting is minimized in the primary 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.

<u>Sediment Removal.</u> Sediment removal from the concrete sediment trap will be performed frequently such that the basin will operate efficiently. On regular UPDES sampling days, the structure will be inspected for sediment content. If a sediment delta is evident at the water level extending to or beyond the first of the mine discharge pipes. Sediment material from the structure will then be removed with a front-end loader and mixed with coal in the adjacent coal storage pile.

Sediment removal from the primary sedimentation pond will be conducted when the sediment level reaches the 60% clean-out level. From the stage-capacity curve presented in Appendix 7-14, the 60% clean-out elevation is 7408.1 feet. The sediment will be transported and disposed of at the waste rock disposal site.

Sediment removal from the overflow pond will be conducted when the sediment level reaches an elevation of 7,243.62 feet or 60% of sediment capacity. The sediment will be transported and disposed of at the waste rock disposal site.

Sediment removal procedures for the waste rock disposal site sedimentation pond are defined in the Waste Rock Volume ~~3~~ of this M&RP.

<u>Excessive Settlement.</u> 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. Excessive settlement has not been observed at either the primary sedimentation pond or the waste rock disposal site sedimentation pond. During construction,

the embankment of the overflow pond will be compacted to an average of 95% of maximum dry density, to minimize the chance of excessive settling.

Embankment Material. During construction of the primary sedimentation pond, overflow 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. During construction the primary sedimentation pond was compacted to an average of 95% of maximum dry density. The sedimentation pond at the waste rock disposal site was compacted to a maximum dry density of 90% as determined by ASTM D1557. During construction of the overflow pond, the embankment of the pond will be compacted to an average of 95% of maximum dry density.

MSHA Sedimentation Ponds. MSHA requirements defined in 30 CFR 77.216 are not applicable at this mine since the existing sedimentation 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 than 20 acre-feet.

Other Sedimentation Ponds. All sedimentation ponds within the permit area have primary and emergency spillways that will, in combination, safely discharge a 25-year, 6-hour precipitation event.

Concrete Sediment Trap, Primary Sedimentation Pond and Overflow Pond. The 25-year, 6-hour storm event was routed through the concrete sediment trap and primary sedimentation

TABLE 7-6

Summary of Watershed Data

Watershed	Curve Number	Area (acres)	Time of Concentration (hours)
DIS-1	80	2.46	0.021
DIS-2	80	9.27	0.226
DIS-3	80	1.40	0.066
DIS-4	80	2.23	0.022
DIS-5	100	0.34	0.008
CBW-1	72	29.8	0.183
DWN-1	79	7.23	0.110
CBE-1	72	12.4	0.187
CBE-2	90	0.30	0.017
CBE-3	90	0.05	0.011
CBE-4	72	3.05	0.119
CBE-5	72	3.88	0.107
ESC-1	72	882	1.36
ESC-2	72	1010	0.875
ESC-3	72	211	0.453
ESC-4	72	468	1.18
ESC-5	72	487	0.776
ESC-6	79	0.92	0.042
ESC-7	79	0.57	0.053
MSH-1	72	1956	1.89
MSH-2	79	0.55	0.046
ESC-1 through ESC-5	72	3058	1.89
DWN-2	79	6.02	0.033
DWN-3	79	2.25	0.028
DWN-4	79	36.74	0.217
DWN-5	79	12.65	0.175
DIS-6	100	0.61	0.015

pond to determine the adequacy of the existing spillways. The concrete sediment trap and sedimentation pond are hydraulically connected since overflow from the basin is discharged to the pond. The computer software SEDIMOT II, as described in Appendix 7-10, was used for the routing. SEDIMOT II assumes that the ponds are full of water up to the spillway elevation at the beginning of the storm event. The overflow pond was designed using HydroCAD version 8.50 software to safely convey the 25-year, 6-hour storm event. HydroCAD assumes that the sediment trap and primary sedimentation pond are full of water up to the spillway at the beginning of the storm.

The stage-capacity data for the sediment trap, primary sedimentation pond, and overflow pond are presented in Tables 7-7, 7-8, and 7-8A. The spillway analysis for the primary sedimentation pond assumes that the primary spillway flowline is raised, per discussions above, to an elevation of 7418.15 feet. Stage-discharge data were computed for both the concrete sediment trap and the sedimentation pond and input directly into SEDIMOT II. The purpose of calculating the stage-discharge relationship in the sediment trap was that the spillway is not a typical design, and SEDIMOT II would not accommodate it directly. A stage-discharge curve was computed for the primary sedimentation pond to incorporate the discharge from both the primary and emergency spillways. The SEDIMOT II input and output for the sediment trap and primary sedimentation pond is contained in Appendix 7-14. The spillway analysis for the overflow pond utilized both HydroCAD version 8.50 and FlowMaster I. HydroCAD was used to calculate the flow rate, FlowMaster was used to calculate the flow velocity. For full calculations see Appendix 7-23.

From the final analysis of the 25-year, 6-hour storm event, the maximum inflow rate to the sediment trap from storm runoff is 2.0 cubic feet per second (cfs) and the maximum outflow rate from the basin is 2.1 cfs. The corresponding high water level in the sediment trap is 7440.0 feet, 1.6 feet below the top of the concrete structure.

TABLE 7-7

Stage-Capacity Curve for the Concrete Sediment Trap

ELEVATION (FT)	AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
7436.1	360.0		0
		1469.0	
7438.7	770.0		1469.0
		756.0	
7439.6	911.0		2225.0
		377.0	
7440.0	974.0		2602.0
		613.0	
7440.6	1069.0		3215.0
		1069.0	
7441.6	1069.0		4284.0

TABLE 7-8

Stage-Capacity Data for the Primary Sedimentation Pond

ELEVATION (FT)	AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
7401.0	188.3		0
		534.9	
7402.0	881.4		534.9
		1122.6	
7403.0	1363.8		1657.5
		1567.1	
7404.0	1770.3		3224.5
		1971.6	
7405.0	2172.8		5196.1
		2390.2	
7406.0	2607.6		7586.3
		2857.8	
7407.0	3108.0		10,444.1
		3387.6	
7408.0	3667.1		13,831.6
		3941.7	
7409.0	4216.3		17,773.3
		4487.6	
7410.0	4758.8		22,260.9
		5030.7	
7411.0	5302.6		27,291.6

TABLE 7-8 (Continued)

Stage-Capacity Data for the Primary Sedimentation Pond

ELEVATION (FT)	AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
		5587.8	
7412.0	5873.0		32,879.4
		6172.5	
7413.0	6471.9		39,051.8
		6877.2	
7414.0	7282.4		45,929.0
		7667.6	
7415.0	8052.8		53,596.6
		8405.6	
7416.0	8758.4		62,002.2
		9105.2	
7417.0	9452.0		71,107.4
		6786.2	
7418.0	9937.1		77,893.5
		4541.1	
7418.15	10,245.7		82,434.6
		1544.4	
7418.3	10,346.3		83,979.3
		7406.7	
7419.0	10,815.8		91,386.0
		11,147.2	
7420.0	11,478.6		102,533.2

TABLE 7-8A

Stage-Capacity Data for the Overflow Pond

ELEVATION (FT)	AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
7238.0	928		0
		1,170	
7239.0	1,413		1,170
		1,655	
7240.0	1,897		2,825
		2,253	
7241.0	2,609		5,078
		2,965	
7242.0	3,320		8,043
		3,728	
7243.0	4,135		11,771
		4,542	
7244.0	4,949		16,313
		5,397	
7245.0	5,844		21,710
		6,292	
7246.0	6,739		28,002
		7,217	
7247.0	7,695		35,219
		8,173	
7248.0	8,651		43,392
		9,178	

TABLE 7-8A (Continued)

Stage-Capacity Data for the Overflow Pond

ELEVATION (FT)	AREA (FT^2)	INCREMENTAL VOLUME (FT^3)	CUMULATIVE VOLUME (FT^3)
7249.0	9,705		52,570
		10,232	
7250.0	10,759		62,802
		11,348	
7251.0	11,937		74,150
		12,526	
7252.0	13,114		86,676
		13,750	
7253.0	14,386		100,441
		15,022	
7254.0	15,658		115,463
		16,359	
7255.0	17,060		131,822

The maximum inflow rate to the primary sedimentation pond is 2.65 cfs and the maximum outflow rate is 2.2 cfs. The corresponding high water level is 7418.35 feet, 0.2 feet above the primary spillway flowline, and 1.65 feet below the minimum embankment elevation of 7420.0.

The maximum design inflow rate to the overflow pond is 6.31 cfs and the maximum design outflow rate is 6.31 cfs. The corresponding high water level is 7253.24, 0.74 feet above the primary spillway flowline, and 1.76 feet below the minimum embankment elevation of 7255.0.

Details for the concrete sediment trap spillway are presented in Appendix 7-8. Details for the primary and emergency spillways on the primary sedimentation pond can be found on Plate 7-5. Details for the overflow pond primary and emergency spillway can be found in Appendix 7-23 and on Plate 7-5A.

Waste Rock Disposal Site Sedimentation Pond. The sedimentation pond at the waste rock disposal site will adequately pass the 25-year, 6-hour precipitation event through the primary and emergency spillways. Details regarding the spillway design are located in the Waste Rock Volume ~~3~~ of this M&RP.

Other Treatment Facilities. There are no other treatment facilities within the mine permit area.

Exemptions. Exemption areas are listed below (see Plate 5-2B):

- The south side of the original substation pad area above the office building. This area is classified as an "Exempt Area". The demonstration for this area is a SEDCAD computer program and is located in Appendix 7-16. The disturbed area is 0.040 acre.

- The spring collection field in Convulsion Canyon. This area is classified as an "Exempt Area". The demonstration for this area is a SEDCAD computer program and is located in Appendix 7-16. The area is fenced to prevent grazing. The disturbed area is 0.39 acre.

- The water tank area northeast of the mine site. This area is classified as an "Exempt Area". The demonstration for this area is a SEDCAD computer program and is located in Appendix 7-16. The disturbed area is 0.193 acre.

The total disturbed area contributing to the primary sedimentation pond is 15.88 acres. The total disturbed area contributing to the overflow pond is 16.49 acres. The total disturbed area contributing to the waste rock disposal site sedimentation pond is 7.93 acres. The total area for Small Area Exemption (SAE) is 0.623 acres. This is 2.1 percent of 30.454 acres of total disturbed area at the mine site, Link Canyon Portal and Substation No. 1 and No. 2 facility sites, and waste rock disposal site (including ASCA's and SAE's).

7.4.2.3 Diversions

General Requirements. The diversions within the permit area consist of drainage ditches and culverts. All diversions within the permit area have been 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.

All diversions and diversion structures have been designed, located, constructed, maintained and used to:

- Be stable
- Provide protection against flooding and resultant damage to life and property
- Prevent, to the extent possible, additional contributions of suspended solids to stream flow outside the permit area
- Comply with all applicable local, state, and federal laws and regulations

All diversions within the permit area are temporary and will be removed when no longer needed. The diversions will be reclaimed in accordance with the reclamation plan defined in Chapter 5.

Peak discharge rates from the undisturbed and disturbed area drainages within the permit area were calculated for use in determining the adequacy of the existing diversion ditches and culverts. The storm runoff calculations for the temporary diversion structures were based on the 10-year, 6-hour precipitation event of 1.3 inches. Curve numbers were based on those defined in Appendix 7-9 and professional judgement. A description of the methods used to determine the peak discharge rates is presented in Appendix 7-10. The overflow pond bypass culvert was designed to safely convey the 100-year, 6-hour precipitation event of 2.06 inches. For more information of designs and calculations see Plates 7-5A, 7-5B, and 7-5C and Appendix 7-23. The sediment trap outfall culvert, primary sediment pond bypass, and overflow pond inlet swale were designed to safely convey the 24-year, 6-hour precipitation event of 1.55 inches. The remaining overflow pond diversion; overflow pond access road channel, west and east overflow pond undisturbed area diversion channels were designed to safely convey the 10-year, 6-hour event.

The disturbed and undisturbed drainage areas for the facilities area are presented on Plate 7-6. Those drainage areas too large to fit on Plate 7-6 can be found on Plate 7-8. A summary of watershed characteristics is presented in Table 7-6. The disturbed and undisturbed drainage areas for the Link Canyon facilities area are presented on Plate 5-2D,E,&F. Link Canyon diversion calculations and designs are presented in Appendix 7-12.

The size and location of each existing diversion ditch and culvert were verified in the field. All diversions are located on Plates 7-6 and 5-2D,E,&F. The minimum capacity and freeboard of each diversion ditch was determined based on the minimum ditch slope, while the maximum velocity and minimum riprap protection was calculated based on the maximum ditch slope. The capacity of each culvert was determined using the minimum culvert slope, and the outlet velocity and riprap protection was verified using the culvert outlet slope. Slopes were measured either in the field or from a contour map with the scale of 1" = 50'. A description of the methods used to determine diversion capacities, flow velocities, and riprap sizes is presented in Appendix 7-10 and 7-23. All diversion calculations are presented in Appendices 7-12, 7-13, and 7-23.

Diversion of Perennial and Intermittent Streams. Flows from the two tributary streams are diverted under the fill area by two large corrugated metal pipes. Both diversions are temporary, and can adequately pass the peak flows from the 10-year, 6-hour precipitation event.

Mud Spring Hollow flows into a 42-inch diameter CMP. The mitered inlet structure is constructed of concrete and has a headwall of approximately 4 feet. It discharges directly into the 72-inch East Spring Bypass culvert. Based on the calculations presented in Appendix 7-11, the peak flow rate from watershed MSH-1 is 38.06 cfs. The minimum culvert slope is 1.8% which results in a maximum flow depth of 1.79 feet. The existing culvert is adequate in size.

The flows in East Spring Canyon are diverted by a 72-inch diameter CMP. This pipe is large enough to handle the flows from East Spring Canyon and Mud Spring Hollow. This CMP extends under the fill area and discharges downstream below the primary sedimentation pond. The size of the bypass narrows to a 48-inch diameter CMP down the steep fill slope.

The peak flow from East Spring Canyon is 59.6 cfs. The concrete inlet structure was evaluated according to methods described in Appendix 7-10. The inlet structure is adequate to pass the design storm event.

An emergency diversion was constructed at the main mine fan for the East Spring Canyon bypass culvert. This 3.5 foot square drop drain with oil skimmer cap connects into a 48-inch culvert directed into the East Spring Canyon bypass culvert. This serves as an overflow system when the trash rack at the inlet to East Spring Canyon becomes plugged with debris.

The combined peak flow from East Spring Canyon and Mud Spring Hollow for the 10-year, 6-hour precipitation event is 97.9 cfs. The capacity of the culvert was evaluated based on this flow rate and a minimum culvert slope of 1.2%. The resulting maximum flow depth of 2.6 feet indicates that the existing culvert is adequate. The capacity of the 48-inch culvert was also verified. The resulting maximum flow depth, corresponding to the minimum slope of 10%, is 1.75 feet. The 48-inch culvert is adequate to pass the design storm.

The discharge velocity from the 48-inch culvert was determined to verify the adequacy of the existing riprap (D_{50} = 15 inches). The calculated outlet velocity, based on a culvert outlet slope of 10%, is 18.5 feet per second. Using methods defined in Appendix 7-10, the required average riprap size at the outlet is 15 inches. The existing riprap is acceptable.

Outfall from the 48-inch East Spring Canyon and Mud Spring Hollow culvert described above flow approximately 800 feet through the natural stream at the canyon bottom into a 66-inch smooth wall CMP culvert whose inlet will be installed immediately upstream from the overflow pond. The 66-inch smooth wall CMP culvert is designed to safely convey the peak flow from a 100-yr, 6-hr storm for East Spring Canyon, Mud Spring Hollow, overflow from the primary sedimentation pond, and undisturbed areas upstream from the overflow pond (DWN-2 and DWN-4). This culvert will discharge immediately below the overflow pond within the natural stream channel. For more information see Plates 7-4 and 7-5A and Appendix 7-23.

The primary sedimentation pond diversion culvert allows discharge from the sedimentation trap to bypass the primary sedimentation pond and flow directly into the overflow pond. This culvert is also designed to allow discharge from the primary sedimentation pond to flow directly into the overflow pond. Due to this culvert acting as a bypass for the primary sedimentation pond the 18-inch CMP sedimentation trap diversion has been designed to convey the 25-year, 6-hour precipitation event. For more information see Plates 7-4 and 7-5A and Appendix 7-23.

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.

Diversion Ditches. 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 is presented in Table 7-9. All calculations are contained in Appendix 7-12 and 7-23. Each ditch was verified in the field and has adequate capacity and erosion protection to pass the 10-year, 6-hour precipitation event. A description of the diversion ditches within the facilities area is presented below:

- Interception ditch along the East Side Road which drains the undisturbed watershed CBE-5. This diversion drains into the CBE bypass culvert at the substation.

- Interception ditch along the East Side Road which drains the undisturbed watersheds CBE-1 through CBE-5. This diversion drains into the CBE continuance diversion.

- Substation pad upper interception ditch which drains the undisturbed watershed CBE-4. This diversion drains into the CBE bypass culvert at the substation.

- Substation pad lower undisturbed interception ditch which drains the watershed CBE-3. This diversion drains into a drop drain for the CBE bypass culvert at the substation and is part of the alternate sediment control measures defined in Section 7.4.2.1.

- Riprap diversion channel for CBE continuance diversion. This diversion carries flows from the lower interception ditch along the East Side Road to an adjacent ephemeral drainage.

- Interception ditch for the undisturbed watershed ESC-6 north of the ATOF. This diversion discharges to the inlet of the 10-inch pipe diversion which connects into the 72-inch East Spring Canyon bypass system.

- Interception ditch for the undisturbed watershed ESC-7 north of the ATOF. This diversion drains to an 8-inch pipe that tees into the 10-inch pipe which drains ESC-6.

- Interception ditch for the undisturbed watershed MSH-2 north of the ATOF. This diversion drains to the inlet of the 42-inch Mud Spring Hollow bypass.

- Interception ditch for the undisturbed watershed MSH-2A north of the ATOF. This diversion drains to the 6-inch pipe diversion which connects into the 72-inch East Spring Canyon bypass system

- Interception ditch draining watershed DIS-1A. This diversion drains to one of the drop drain inlets of the 10-inch mine yard drain line.

- Sedimentation pond access road diversion ditch. This diversion drains the disturbed watershed DIS-3 and discharges to the sedimentation pond.

- Main access road diversion ditch which drains undisturbed watershed DWN-1. This ditch drains to the pipe number 5 diversion.

- Link Canyon Substation No. 1 ditch which drains the watersheds LINK and ASCA-1. This diversion diverts the upper undisturbed drainage around the substation and drains to the Link Canyon Substation No. 1 road swale. This diversion ditch was reclaimed in 2000.

- Link Canyon Substation No. 1 road swale which drains watersheds LINK, ASCA-1, and ASCA-3. This diversion carries flows from the Link Canyon Substation No. 1 ditch across the substation access road to the main Link Canyon road drainage. This diversion was reclaimed in 2000.

- Link Canyon Substation No. 2 ditch which drains the watersheds LINK No.2, ASCA-4 and ASCA-7. This diversion diverts the upper undisturbed drainage around the substation and drains to the main Link Canyon road drainage.

- Link Canyon Portal access road Channel No. 1 diversion ditch. This diversion diverts the access road disturbed drainage and the undisturbed drainage above the road to the Link Canyon drainage bypass culvert inlet.
- Link Canyon Portal Pad Channel No. 2 diversion ditch. This diversion diverts the pad area disturbed drainage and the undisturbed drainage above the pad to the Link Canyon drainage bypass culvert inlet.

- The west overflow pond undisturbed area diversion channel. This channel diverts runoff from the undisturbed area immediately west of the overflow pond and conveys the runoff south to the overflow pond access road channel.
- The overflow pond access road channel. This channel diverts runoff from the undisturbed area immediately west of the overflow pond access road and runoff from the west overflow pond channel south along the west side of this road to a swale and across U.S.F.S road.
- The east overflow pond undisturbed area diversion channel (shallow section). This channel diverts runoff from the undisturbed area immediately east of the overflow pond and conveys the runoff south to the face of the overflow pond impound.
- The east overflow pond undisturbed area diversion channel (steep section). This channel collects runoff from the east overflow pond channel shallow section and diverts it down the impoundment face into the existing natural stream channel at the bottom of east spring canyon.
- The overflow pond inlet swale. This swale conveys outfall from gate box #2 south to the overflow pond. This swale will be designed to allow track hoes and bull dozers to drive across it for maintenance purposes.

A description of the diversion ditches within the waste rock disposal site can be found in the Waste Rock Volume ~~3~~ of this M&RP.

(Table 7-9)

Summary of Diversion Ditches

(Table 7-10)

Summary of Diversion Culverts

Diversion Culverts. A summary table of the culvert size, slope, peak discharge, existing riprap at outlet, and outlet flow velocity for each culvert within the facilities area is presented in Table 7-10. All calculations are contained in Appendix 7-13. Each culvert has adequate capacity and outlet erosion protection to pass the 10-year, 6-hour precipitation event. The primary sediment diversion culvert allows discharge from the sedimentation trap to bypass the primary sedimentation pond. Therefore this culvert must have adequate capacity to safely pass the peak flow resulting from the 25-year, 6-hour precipitation event. To ensure that the overflow pond embankment remains stable during 100-year, 6-hour storm, the overflow pond bypass culvert was designed to have adequate capacity and erosion protection to pass the 100-year, 6-hour precipitation. A description of the diversion culverts within the facilities area is presented below:

- East Spring Canyon bypass culvert. This culvert drains the undisturbed watersheds ESC-1 through ESC-5 and extends under the fill area and discharges downstream below the primary sedimentation pond.

- Mud Spring Hollow bypass culvert. This culvert drains the undisturbed watershed MSH-1 and connects into the 72-inch East Spring Canyon bypass culvert system.

- CBE bypass culvert at the substation. This culvert drains the undisturbed watersheds CBE-2 through CBE-5 and discharges to the lower East Side Road interception ditch. Three drop drains direct the flows to the bypass culvert. The drop drains help reduce the time the runoff water will be on the pad area to reduce the chance of water migrating through the substation pad fill and lubricating the substation slide slip zone.

- Pipe No. 5 diversion culvert which drains the undisturbed area DWN-1. This culvert discharges below the sedimentation pond access road to the natural slope. It does not drain to the pond.

- 10-inch pipe diversion for undisturbed watersheds ESC-6 and ESC-7. This pipe connects into the 72-inch East Spring Canyon bypass system.

- 8-inch pipe diversion for undisturbed watershed ESC-7. This pipe connects to the 10-inch pipe that drains undisturbed watershed ESC-6.

- 6-inch pipe diversion for undisturbed watershed MSH-2A. This pipe connects into the 72-inch East Spring Canyon bypass system.

- Main Mine Fan Diversion. The main mine fan is located in a depression which is nine feet below the adjacent mine yard drainage system. A sump pump with automatic float controls in front of the main fan will pump the runoff from this area into the 10-inch mine yard drain line.

- 10-inch mine yard drainage system. This drainage system was installed to handle normal surface flows in the mine yard and to reduce the occurrence of mud and erosion. The drainage system consists of drop inlets and a 10-inch pipeline discharging to the concrete sediment trap. It was not designed to pass the 10-year, 6-hour precipitation event. Instead, the surface area of the mine yard is graded to divert all runoff to the concrete sediment trap.

- The sediment trap diversion culvert allows the sedimentation pond to drain for sediment removal. This culvert discharges to the overflow pond.

- The 66-inch overflow pond bypass culvert allows watersheds DWN-1, DWN-2, DWN-3, MSH-1, MSH-2, and ESC-1 through ESC-7 to bypass the overflow pond. This culvert discharges immediately downstream of the overflow pond.

A description of all diversion culverts within the waste rock disposal site can be found in the Waste Rock Volume ~~3~~ of this M&RP.

7.4.2.4 Road Drainage

All Roads. The existing roads within the facilities area are the mine access road, the primary sedimentation pond access road, the east side road, and overflow pond access road. The existing road within the Link Canyon facilities area is the substation access road. All of the roads have been constructed to include adequate drainage control with the use of diversion ditches, culverts, and containment berms. None of the roads are located in the channel of an intermittent or perennial stream. All roads have been located to minimize downstream sedimentation and flooding. Diversion ditches and culverts for all roads are described in Section 7.4.2.3 above.

Primary Roads. The mine access road is the only primary road within the permit area. The mine access is located, where practical, to minimize erosion. The access road does not ford any stream channels.

The drainage control system for the mine access road includes a diversion ditch, culvert, and berm. The diversions will adequately pass the peak runoff from the 10-year, 6-hour precipitation event. Drainage details for the access road are presented in Section 7.4.2.3 above.

The culvert draining the undisturbed area DWN-1 adjacent to the mine access road is identified as pipe no. 5. It is constructed with an mitered inlet with a trash rack to avoid plugging. The outlet of the culvert, located below the primary sedimentation pond access road, is adequately lined with riprap to prevent erosion. Refer to Section 7.4.2.3 for additional drainage details. The diversion ditch and culvert will be maintained and operated as described in Section 7.3.2.3. No natural stream channels were relocated for the construction of the mine access road.

7.4.3 Impoundments

The existing impoundments within the permit area consist of the four structures constructed for sediment control purposes. These structures are:

- The concrete sediment trap located near the southern end of the mine yard.
- The primary sedimentation pond located immediately below the fill on which the existing mine facilities are constructed.
- The overflow pond located approximately 800 feet below the primary sedimentation pond.

- The sedimentation pond located at the waste rock disposal site.

All pertinent information regarding these sedimentation ponds is presented in Sections 7.3.2.2 and 7.4.2.2.

7.4.4 Discharge Structures

The discharge structures within the permit area consist of the primary and emergency spillways on each sedimentation pond. The spillways on all sedimentation ponds within the permit area will adequately pass the peak discharge from the 25-year, 6-hour precipitation event. Detailed information for each sedimentation pond is presented in Sections 7.3.2.2 and 7.4.2.2.

The spillway of the concrete sediment trap consists of an overflow weir which discharges to a 24-inch CMP culvert. The culvert drains into canal box #1. From this canal box it drains either into a 24-inch culvert, then directly into the primary sediment pond, or into the 18-inch primary sediment pond bypass. Specific construction details of the spillway system for the sediment trap are presented in Plates 7-4 and 7-5A and Appendix 7-8 and 7-23.

The primary spillway on the primary sedimentation pond consists of a 12-inch steel riser with a covered oil-skimmer. The primary spillway discharges directly to the 18-inch primary sediment pond bypass culvert. The emergency spillway is a trapezoidal open channel lined with riprap. The bottom width is 14 feet with side slopes of 2:1 (horizontal:vertical). This spillway discharges to the downstream natural drainage system. The design calculations for the spillways are presented in Appendix 7-14 and 7-23. The details for each spillway are presented on Plate 7-5.

The primary spillway on the overflow pond consists of a 24-inch steel riser with an oil-skimmer. The primary spillway discharges directly to the riprap lined emergency spillway channel below the pond. The emergency spillway is a trapezoidal open channel lined with riprap. The top section of the spillway has a bottom width of 1 feet with side slopes of 12H:1V to allow vehicles to be driven across the spillway for maintenance access. The sloped section of the spillway, or bottom section, slopes down the face of the impoundment at 3H:1V with a 1 foot wide bottom. The emergency spillways discharge to the downstream natural drainage system. The primary spillway discharges through a flume to measure flow and then enters the natural drainage system. The details for each spillway are presented on Plate 7-5A.

Details for the discharge structures on the waste rock disposal site sedimentation pond are presented in the Waste Rock Volume ~~3~~ of this M&RP.

7.4.4.1 Erosion Protection

Each discharge structure was evaluated to determine the adequacy of the existing riprap, and capacity of the structure during the 25-year, 6-hour precipitation event. The calculations for the discharge structures within the facilities area are presented in Appendix 7-14.

The discharge structure on the overflow pond was evaluated to determine the size of the riprap, and capacity of the structure during the 25-year, 6-hour precipitation event. The calculation for the discharge structures within the overflow pond are presented in Appendix 7-23.

The 24-inch CMP from the concrete sediment trap discharges to the primary sedimentation pond. The outlet slope, measured in the field, is 53%. The peak discharge from the sediment trap is 2.1 cubic feet per second. Using methods discussed in Appendix 7-10, the flow velocity at the culvert outlet is 11.8 feet per second. The flow depth at the outlet is 0.21 feet.

The erosion protection at the culvert outlet consists of one large boulder, 6 to 8 feet in diameter, located approximately 10 feet below the outlet. In addition, riprap with the average size of 14 inches is located at the immediate vicinity of the outlet. Based on methods defined in Appendix 7-10 and an outlet velocity of 11.8 feet per second, an average riprap size of 15 inches is required at the outlet. Therefore, the combination 14-inch riprap and 6-foot boulder erosion protection at the culvert outlet is adequate.

The 12-inch primary spillway on the primary sedimentation pond discharges to 18-inch primary sediment pond bypass. The emergency spillway channel has a bottom width of 14 feet, side slopes of 2H:1V, and an average riprap size of 15 inches.

The adequacy of the existing riprap was initially evaluated assuming the peak discharge of 2.2 cfs flows exclusively down the emergency spillway. In this case, assuming a maximum channel slope of 71%, the maximum flow velocity is 3.7 feet per second. This is considered non-erosional. Finally, the riprap was evaluated assuming the peak discharge flows exclusively through the 12-inch primary spillway. In this case, assuming an outlet slope of 35%, the maximum flow velocity is 11.1 feet per second at the culvert outlet. Using methods defined in Appendix 7-10, the required average riprap size to provide adequate protection is 12 inches. Therefore, the existing 15-inch riprap is acceptable.

The 18-inch primary spillway on the overflow pond discharges into a flume to measure the outlet flow. From the flume discharge enters the historic natural drainage path. The top or upper emergency spillway channel has a bottom width of 1 feet, side slopes of 12H:1V and an average riprap size of 2-inches. The bottom section, which slopes down the face of the impoundment, has a 1 foot wide bottom, with 2H:1V side slopes and slopes down the impoundment at a 3H:1V.

Assuming a maximum channel slope of 33.3%, the maximum flow velocity for the emergency spillway is 5.53 feet per second. The riprap was evaluated assuming the peak discharge flows exclusively through the 18-inch primary spillway. In this case, assuming an outlet slope of 5.88%, the maximum flow velocity is 4.35 feet per second at the culvert outlet. Using methods defined in Appendix 7-10; the required average riprap size to provide adequate protection for the channel above the primary spillway outfall is 2-inches, and the required average riprap size to provide adequate protection for the channel below the primary spillway outfall is 2-inches.

The riprap design for the discharge structures on the waste rock disposal site sedimentation pond is presented in the Waste Rock Volume ~~3~~ of this M&RP.

7.4.4.2 Design Standards

All discharge structures within the permit area were designed and constructed according to standard engineering design procedures.

7.4.5 Disposal of Excess Spoil

There is no excess spoil within the permit area.

7.4.6 Coal Mine Waste

7.4.6.1 General Requirements

All coal mine waste is contained within the waste rock disposal site. All coal mine waste will be placed in a controlled manner to minimize adverse effects of leachate and surface water runoff on surface and groundwater quality and quantity. A description of the methods of placement can be found in the Waste Rock Volume ~~3~~ .

7.4.6.2 Refuse Piles

A detailed description of the refuse piles at the waste rock disposal site can be found in Chapter 5 and the Waste Rock Volume ~~3~~ of this M&RP.

Based on the size, configuration, and open graded structure of the waste rock fill and its location at the site, no underdrains or rock core chimney drains were required. There are no springs or seeps within the fill area which require special treatment.

All surface precipitation falling on the fill is channeled to the sedimentation pond located down gradient from the toe of the disposal area fill. All surface drainage from the areas above the site is diverted around the disposal area using diversion ditches. Surface drainage from the county road above the site is controlled by a shoulder ditch and diverted away from the fill area. All diversions are lined with either riprap, concrete, or vegetation to minimize surface erosion at the site.

No permanent impoundments will exist on the completed refuse pile.

7.4.6.3 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.

7.4.6.4 Return of Coal Processing Waste to Abandoned Underground Workings

Coal processing waste is not returned to abandoned underground workings at this facility.

7.4.7 Disposal of Noncoal Mine Waste

Disposal of noncoal mine waste is discussed in Chapter 5.

7.4.8 Casing and Sealing of Wells

Each water well has 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. The drill logs and completion diagrams for the water wells are contained in Appendix 6-1.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the UDOGM.

7.50 Performance Standards

All 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.

7.5.1 Water Quality Standards and Effluent Limitations

Discharges of water from disturbed areas will be in compliance with all Utah and federal water quality laws and regulations and with effluent limitations for coal mining contained in 40 CFR Part 434.

7.5.2 Sediment Control Measures

All sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 7.3.2, 7.4.2, and 7.6.0.

7.5.2.1 Siltation Structures and Diversions

Siltation structures and diversions will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 7.3.2, 7.4.2, and 7.6.3.

7.5.2.2 Road Drainage

All roads will be located, designed, constructed, reconstructed, used, maintained and reclaimed according to plans and designs presented in Sections 7.3.2.4, 7.4.2.4, and 7.6.2. All 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 7.5.1.

- 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 streambeds or drainage channels.

7.5.3 Impoundments and Discharge Structures

Impoundments and discharge structures will be located, maintained, constructed and reclaimed as described in Sections 7.3.3, 7.3.4, 7.4.3, 7.4.5, and 7.6.0.

7.5.4 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 7.3.6, 7.3.7, 7.4.6, 7.4.7, 7.6.0 and Chapter 5.

7.5.5 Casing and Sealing of Wells

All wells will be managed as described in Sections 7.4.8 and 7.6.5. Water monitoring wells will be managed on a temporary basis as described in Section 7.3.8.

7.60 Reclamation

7.6.1 General Requirements

A detailed reclamation plan for the mine is presented in Section 5.40. In general, SUFCO will ensure that all temporary structures are removed and reclaimed. SUFCO plans to remove all culverts within the surface facility area during final reclamation. Permanent diversions will be maintained properly and will meet the requirements of the approved reclamation plan for permanent structures and impoundments. SUFCO will renovate the diversion structures if necessary to meet the requirements of R645-301 and R645-302 and to conform to the approved reclamation plan.

7.6.2 Roads

A road 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.

7.6.2.1 Restoring the Natural Drainage Patterns

All natural drainage patterns will be restored.

7.6.2.2 Reshaping Cut and Fill Slopes

All 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.

7.6.3 Siltation Structures

7.6.3.1 Maintenance of Siltation Structures

All siltation structures will be maintained until removed in accordance with the approved reclamation plan.

7.6.3.2 Removal of Siltation Structures

When the 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 5.40. Because of the narrow confines of East Spring Canyon it is not practical to remove the mine fill area and restore the area to approximate original contour without removing the sediment pond at the base of the fill. Interim sediment control measures as discussed in Section 5.40 will be implemented during the reclamation stage.

7.6.4 Structure Removal

A timetable for the removal of each structure is presented in Figure 5-2.

7.6.5 Permanent Casing and Sealing of Wells

When no longer needed for monitoring or other use approved by the UDOGM upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the UDOGM. Wells will be sealed and backfilled by placing a concrete plug from TD to surface. Permanent closure measures will be designed to prevent access to the mine workings by people, livestock, fish and wildlife, machinery and to keep acid or other toxic drainage from entering ground or surface waters.

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APPENDIX 7-1

Water Rights Data

Greens Hollow Tract

Search of TOWNSHIP = '20S' and RANGE = '4E' and BEM = 'SL'

WR Number	Diversion Type	Well Log	Location	Status	Priority	Uses	CFS	ACFT	Address	Owner Name	Latitude	Longitude
94-342	Point to Point		S660 W660 E4 19 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0519957537	-111.507670527
94-343	Point to Point		N660 E660 S4 02 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922188478	-111.437923863
94-399	Point to Point		S660 W1980 E4 01 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0963880645	-111.419104896
94-401	Point to Point		N660 E1980 W4 01 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1001631064	-111.423907198
94-407	Point to Point		S1980 E660 N4 01 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1008265918	-111.419117794
94-408	Point to Point		N660 E1980 W4 01 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1001631064	-111.423907198
94-409	Point to Point		N660 E1980 W4 02 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1003081135	-111.442535654
94-415	Point to Point		N660 W660 S4 01 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0920991774	-111.423872294
94-481	Point to Point		N1 W1600 SE 25 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0322862255	-111.417885168
94-482	Point to Point		N1 E1700 SW 25 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0323669523	-111.424821745
94-483	Point to Point		N1 E2350 SW 35 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0176327112	-111.441181235
94-484	Point to Point		N2200 E1 SW 26 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0383437371	-111.449497953
94-485	Point to Point		N1 W600 SE 34 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0175928133	-111.451567888
94-497	Point to Point		N300 W50 SE 30 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0331580379	-111.50553208
94-498	Point to Point		S2600 W4000 NE 29 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0395652378	-111.500708347
94-499	Point to Point			P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0441640386	-111.503058328

		S900 E650 NW 29 20S 4E SL									
94-500	Point to Point	S1 W2000 NE 29 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0467335758	-111.493714113
94-501	Point to Point	N2100 E710 SW 21 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0525441675	-111.484208017
94-502	Point to Point	N2250 E1 SW 22 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0528090661	-111.467997899
94-503	Point to Point	S100 E400 NW 23 20S 4E SL	P	1879	S	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	39.061067718	-111.448070895
94-504	Point to Point	S1500 W1100 NE 27 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0425839372	-111.453350797
94-507	Point to Point	N900 E200 SW 14 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0638115264	-111.448792899
94-508	Point to Point	S1400 E1 NW 23 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0574918049	-111.449453952
94-509	Point to Point	S2100 E1350 NW 13 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0701010056	-111.426072708
94-510	Point to Point	S2600 W600 NE 14 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0687023534	-111.432935176
94-511	Point to Point	N1300 W600 SE 14 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0649846068	-111.433111866
94-512	Point to Point	S520 E1100 NW 13 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0744372851	-111.426979738
94-513	Point to Point	S1 E1850 NW 13 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0758724081	-111.424345474
94-514	Point to Point	N660 E660 W4 20 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0556413694	-111.503046586
94-515	Point to Point	S660 E660 NW 20 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0592085675	-111.503013941
94-516	Point to Point	N660 W660 E4 19 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0556211555	-111.507696492
94-517	Point to Point	S660 E660 N4 20 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0593234438	-111.493661394
94-518	Point to Point	N660 W660 E4 20 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0558062471	-111.488995388
94-519	Point to Point	S660 W660 E4	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.05207843	-111.470305168

		21 20S 4E SL							
94-520	Point to Point	S660 E660 W4 16 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0667928071 -111.48430162
94-521	Point to Point	S660 W660 N4 22 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0594327618 -111.461066281
94-522	Point to Point	S660 W1980 E4 16 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0666810133 -111.475042707
94-523	Point to Point	S660 W1980 E4 16 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0666810133 -111.475042707
94-524	Point to Point	S660 W1980 E4 16 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0666810133 -111.475042707
94-525	Point to Point	N660 E660 SW 15 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0629937094 -111.46571051
94-526	Point to Point	N660 E660 SW 15 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0629937094 -111.46571051
94-527	Point to Point	S660 E660 N4 22 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0594511125 -111.456415956
94-528	Point to Point	N660 W660 S4 15 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0630581739 -111.461089867
94-529	Point to Point	N660 E660 S4 15 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.063076526 -111.456439304
94-530	Point to Point	S660 W1980 E4 15 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0668225471 -111.456482068
94-531	Point to Point	S660 E660 N4 14 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0741160072 -111.437871768
94-532	Point to Point	S660 W1980 E4 11 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0812691646 -111.437858488
94-534	Point to Point	S660 W1980 E4 11 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0812691646 -111.437858488
94-535	Point to Point	S660 W660 N4 14 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0740983942 -111.442523068
94-537	Point to Point	N660 W660 SE 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0777916197 -111.451890117
94-538	Point to Point	S660 W660 E4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0813868956 -111.451870045

94-539	Point to Point	N660 E660 S4 02 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922188478 -111.437923863
94-540	Point to Point	N660 E660 S4 03 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922384248 -111.456588061
94-541	Point to Point	N660 W660 S4 03 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.092220063 -111.461240542
94-542	Point to Point	S1980 E660 N4 03 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1010581009 -111.456391269
94-543	Point to Point	S660 E660 W4 02 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0966649185 -111.447165771
94-544	Point to Point	S660 E1980 W4 02 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0966827193 -111.442512988
94-545	Point to Point	S660 E660 W4 02 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0966649185 -111.447165771
94-546	Point to Point	S660 E1980 W4 02 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0966827193 -111.442512988
94-547	Point to Point	N660 E660 S4 02 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922188478 -111.437923863
94-548	Point to Point	N660 W660 SE 02 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0921687518 -111.433256464
94-549	Point to Point	N660 E1980 W4 15 20S 4E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.0703625912 -111.461113911
94-550	Point to Point	N660 E660 SW 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0776943846 -111.465819409
94-551	Point to Point	N660 E660 SW 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0776943846 -111.465819409
94-552	Point to Point	N660 E660 SW 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0776943846 -111.465819409
94-553	Point to Point	S660 E660 W4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0813343737 -111.465852021
94-554	Point to Point	S660 E660 W4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0813343737 -111.465852021
94-555	Point to Point	S660 W660 N4 16 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0740897812 -111.479696311
94-556	Point to Point	S660 W660 N4	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0740897812 -111.479696311

		16 20S 4E SL							
94-557	Point to Point	N660 E660 SW 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0777734321 -111.484319293
94-558	Point to Point	S660 W660 N4 17 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0740110856 -111.498345253
94-559	Point to Point	N660 W660 SE 08 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0777539661 111.488970804
94-560	Point to Point	N660 E660 S4 08 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0776563172 -111.493719265
94-561	Point to Point	S660 E660 W4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0813854452 -111.484306939
94-562	Point to Point	N660 E1980 W4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0850301181 -111.479679743
94-563	Point to Point	S660 E660 W4 04 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0966188072 -111.484284121
94-564	Point to Point	S660 W1980 E4 04 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0965932184 -111.47511908
94-565	Point to Point	N660 W660 E4 04 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1002375204 -111.47049042
94-566	Point to Point	S660 W1980 E4 05 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0965796865 -111.493589618
94-567	Point to Point	S1980 E660 N4 05 20S 4E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.1008475263 -111.493712983
94-568	Point to Point	S660 E660 NW 04 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1046147586 -111.484248859
94-571	Point to Point	0 0 NE 04 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1064653143 -111.468057244
94-575	Point to Point	S660 W660 N4 17 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0740110856 -111.498345253
94-582	Point to Point	N660 W660 S4 01 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0920991774 -111.423872294
94-593	Point to Point	N660 E660 S4 02 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922188478 -111.437923863
94-594	Point to Point	N660 W660 S4 08 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0776364763 -111.498370762
94-598			P	1879	S	0.000 0.000			39.0466235851 -111.47007405

	Point to Point	N1 W600 SE 21 20S 4E SL						324 - 25TH STREET	USA FOREST SERVICE		
94-600	Point to Point	N660 E660 W4 22 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0557225634	-111.465679147
94-605	Point to Point	N660 E660 S4 02 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922188478	-111.437923863
94-606	Point to Point	S660 W660 N4 17 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0740110856	-111.498345253
94-609	Point to Point	S660 E660 N4 04 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1046387294	-111.47498374
94-610	Point to Point	S660 E660 N4 04 20S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1046387294	-111.47498374
94-482	Point to Point	N550 E1600 SW 24 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0483997181	-111.425273263
94-483	Point to Point	S1950 W2150 NE 26 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0414842887	-111.438439945
94-485	Point to Point	N1800 W1150 SE 27 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0372293741	-111.453544668
94-486	Point to Point	N1700 W1250 SE 27 20S 4E SL	P	1879	S	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	39.0369533456	-111.453895098
94-496	Point to Point	N2300 E1900 SW 27 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0386360177	-111.461329858
94-497	Point to Point	S1900 E500 NW 33 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0269799829	-111.484794966
94-498	Point to Point	S1700 W2350 NE 29 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.042061992	-111.494914355
94-499	Point to Point	N2500 E400 SW 26 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0391731248	-111.448097911
94-500	Point to Point	S1950 W800 NE 29 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0413984709	-111.489450372
94-501	Point to Point	S2450 W2110 NE 28 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0398702114	-111.47534764
94-502	Point to Point	N550 E1600 SW 24 20S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0483997181	-111.425273263
94-503	Point to Point	S1350 E2300 NW	P	1879	S	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	39.0576601656	-111.4413557

		23 20S 4E SL							
94-504	Point to Point	N1200 W300 SE 22 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0500105346 -111.450580203
94-508	Point to Point	S600 W1450 NE 23 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0597550035 -111.436074529
94-509	Point to Point	S1800 E1550 NW 24 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0564983366 -111.425485736
94-510	Point to Point	N1150 E350 SW 13 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0645850513 -111.429762268
94-511	Point to Point	N700 E350 SW 13 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0633491129 -111.429754773
94-512	Point to Point	S1500 E2400 NW 13 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0717624257 -111.422382834
94-516	Point to Point	S1980 E660 N4 20 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.05569804 -111.493636143
94-517	Point to Point	S660 E660 N4 20 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0593234438 -111.493661394
94-518	Point to Point	S660 E660 W4 21 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0522003016 -111.484320549
94-520	Point to Point	N660 W660 E4 22 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0558315586 -111.451828747
94-522	Point to Point	S660 W660 N4 22 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0594327618 -111.461066281
94-523	Point to Point	N660 W660 SE 16 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0629749876 -111.470361062
94-524	Point to Point	N660 W660 SE 16 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0629749876 -111.470361062
94-525	Point to Point	N660 W660 SE 16 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0629749876 -111.470361062
94-527	Point to Point	N660 W660 E4 22 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0558315586 -111.451828747
94-528	Point to Point	N660 W660 E4 22 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0558315586 -111.451828747
94-529	Point to Point	S660 E660 NW 23 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0595331895 -111.447145197

94-530	Point to Point	S660 E660 W4 14 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0668586993 -111.447180436
94-531	Point to Point	S660 E660 W4 14 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0668586993 -111.447180436
94-532	Point to Point	S660 E660 N4 14 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0741160072 -111.437871768
94-535	Point to Point	N660 E660 W4 14 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0704841109 -111.447203317
94-537	Point to Point	S660 W660 NE 15 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.074166214 -111.45186699
94-538	Point to Point	N660 E660 S4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0777523657 -111.456529005
94-539	Point to Point	S660 W1980 E4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0813687234 -111.456521815
94-540	Point to Point	N660 E660 W4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849597706 -111.465875871
94-541	Point to Point	N660 E660 W4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849597706 -111.465875871
94-542	Point to Point	N660 W660 SE 03 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922329646 -111.451896246
94-543	Point to Point	N660 E660 SW 02 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922509536 -111.447243758
94-544	Point to Point	N660 E660 SW 02 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922509536 -111.447243758
94-549	Point to Point	S660 E660 N4 15 20S 4E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.0741269614 -111.45650564
94-550	Point to Point	N660 W660 S4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0777340081 -111.461180533
94-551	Point to Point	N660 E660 S4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0777523657 -111.456529005
94-552	Point to Point	S660 E1980 W4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0813529181 -111.46120026
94-553	Point to Point	S660 W1980 E4 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0813687234 -111.456521815
94-554	Point to Point	S660 E1980 W4	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0813529181 -111.46120026

		10 20S 4E SL								
94-555	Point to Point	N660 W660 E4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849410392	-111.470527867
94-556	Point to Point	S660 E660 NW 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.088599755	-111.465908494
94-557	Point to Point	N660 W660 S4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0777151781	-111.479720864
94-559	Point to Point	S660 W660 N4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0885925628	-111.479766171
94-560	Point to Point	S660 E660 NW 10 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.088599755	-111.465908494
94-561	Point to Point	N660 E1980 W4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0850301181	-111.479679743
94-562	Point to Point	S660 W660 N4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0885925628	-111.479766171
94-563	Point to Point	N660 E660 S4 04 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922370525	-111.475138272
94-564	Point to Point	N660 W660 SE 04 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922064126	-111.470584827
94-566	Point to Point	N660 E1980 W4 04 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1002634719	-111.479655935
94-567	Point to Point	N660 E660 W4 04 20S 4E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.1002441885	-111 484308929
94-568	Point to Point	N660 E1980 W4 04 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1002634719	-111.479655935
94-570	Point to Point	S660 E660 N4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0886116632	-111.475113941
94-582	Point to Point	N660 W660 S4 01 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0920991774	-111.423872294
94-593	Point to Point	N660 W660 S4 02 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922012306	-111.442576355
94-594	Point to Point	S1980 E660 N4 08 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0848602607	-111.493681502
94-595	Point to Point	S660 E660 N4 09 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0886116632	-111.475113941

94-598	Point to Point	N1700 E1220 SW 22 20S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0513156831	-111.463693922
65-2429	Surface	S3848 E712 NW 06 20S 4E SL	P	19891220	O	0.000 320.000	1594 WEST NORTH TEMPLE, STE 2110	STATE OF UTAH DIVISION OF WILDLIFE RESOURCES	39.0955801354	-111.515509254
94-1134	Surface	S35 W100 NE 10 20S 4E SL	P	1882	DIMS	0.000 300.000	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0903317928	-111.449910334
94-2	Surface	S650 E1610 NW 04 20S 4E SL	P	19130111	DIMS	0.000 51.300	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.1046561192	-111.480900094
94-2	Rediversion	N1175 W1003 SE 04 20S 4E SL	P	19130111	DIMS	0.000 51.300	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.093615965	-111.471803187
94-32	Surface	S1650 W1050 NE 20 20S 4E SL	P	19511219	DIMS	0.000 218.000	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0566932661	-111.490314189
94-33	Surface	N1850 W245 SE 28 20S 4E SL	P	19610818	DIMS	0.000 724.940	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0373698499	-111.468876237
94-33	Surface	S2420 W1700 NE 27 20S 4E SL	P	19610818	DIMS	0.000 724.940	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0400488632	-111.455447852
94-33	Rediversion	N150 W1225 SE 22 20S 4E SL	P	19610818	DIMS	0.000 724.940	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0471139999	-111.453820064
94-40	Surface	S35 W100 NE 10 20S 4E SL	P	19501212	DIMS	0.000 8.000	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0903317928	-111.449910334
94-47	Surface	S650 E1610 NW 04 20S 4E SL	P	19581112	DIMS	0.000 238.700	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.1046561192	-111.480900094
94-47	Rediversion	N1175 W1003 SE 04 20S 4E SL	P	19581112	DIMS	0.000 238.700	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.093615965	-111.471803187
94-487	Spring	S1400 E150 NW 35 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0284582201	-111.448910619
94-488	Spring	S2300 E1600 NW 34 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0259977455	-111.462304103
94-489	Spring	S2200 E2250 NW 34 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0262814812	-111.460017032
94-490	Spring	S1200 E2500 NW 34 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.029031503	-111.459154473
94-491	Spring	S1100 E1700 NW 34 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0292949937	-111.461973429

94-492	Spring	S300 W1850 NE 33 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0314418646	-111.474489336
94-493	Spring	S1200 W1900 NE 33 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0289692635	-111.474648877
94-494	Spring	S100 W800 NE 33 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0320062066	-111.470795328
94-495	Spring	N2400 E400 SW 33 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.024216783	-111.48533617
94-506	Spring	S700 E400 NW 27 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0447124553	-111.466539052
94-55	Surface	S35 W100 NE 10 20S 4E SL	P	1900	DIMS	0.000 117.000	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0903317928	-111.449910334
94-56	Surface	S1650 W1050 NE 20 20S 4E SL	P	1900	DIMS	0.000 251.000	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0566932661	-111.490314189
94-57	Surface	S35 W100 NE 10 20S 4E SL	P	1900	DIMS	0.000 225.000	P.O. BOX 104	MUDDY CREEK IRRIGATION COMPANY	39.0903317928	-111.449910334
94-599	Spring	N250 E250 SW 22 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0473195373	-111.467084574
94-601	Spring	N350 W800 SE 21 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0475792712	-111.470784881
94-603	Spring	S500 E2050 NW 34 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0309478096	-111.460751615
94-604	Spring	S500 E500 NW 34 20S 4E SL	P	1879	S	0.011 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.030926044	-111.466210023
94-612	Spring	N670 W800 SE 21 20S 4E SL	P	1879	S	0.011 0.000	324 - 24TH STREET	USA FOREST SERVICE	39.0484581602	-111.470790716

Search of TOWNSHIP = '20S' and RANGE = '5E' and BEM = 'SL'

WR Number	Diversion Type	Well Log	Location	Status	Priority	Uses	CFS	ACFT	Address	Owner Name	Latitude	Longitude
93-2275	Point to Point		N660 W660 SE 01 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0920841057	-111.301820334
93-2281	Point to Point		S660 E1980 W4 12 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0812626401	-111.311035499
93-2282	Point to Point		S660 W1980 E4 12 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.081176727	-111.30644109
93-2283	Point to Point		S660 E1980 W4 12 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0812626401	-111.311035499
93-2284	Point to Point		S1980 E660 N4 12 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0848673463	-111.306401929
93-2285	Point to Point		N660 E660 W4 12 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0848755169	-111.315703489
93-2286	Point to Point		N660 E660 S4 02 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0921602084	-111.325006689
93-2287	Point to Point		S660 W660 E4 03 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0957861699	-111.338922638
93-2288	Point to Point		N660 W660 E4 03 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0994115884	-111.338939989
93-2289	Point to Point		N660 E660 W4 02 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0994250709	-111.334286966
93-2290	Point to Point		S660 W660 NE 02 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.1030298303	-111.320297732
93-2291	Point to Point		S660 W660 NE 02 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.1030298303	-111.320297732
93-2292	Point to Point		S660 W660 NE 02 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.1030298303	-111.320297732
93-2293	Point to Point		S660 W660 NE 02 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.1030298303	-111.320297732
93-2296	Point to Point		S660 W660 N4 01 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.1030443744	-111.31101713
93-2297	Point to Point		S660 W660 N4 01 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.1030443744	-111.31101713
93-2298	Point to Point		N660 W660 SE 02 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0921268257	-111.320351348
93-2299	Point to Point		N660 E660 S4 02 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0921602084	-111.325006689
93-2300				P	1877	S	0.011	0.000			39.0921602084	-111.325006689

	Point to Point	N660 E660 S4 02 20S 5E SL						FEDERAL BUILDING	USA FOREST SERVICE	
93-2301	Point to Point	S660 W660 NE 01 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.1030581798 -111.301736519
93-2302	Point to Point	S1980 E660 N4 01 20S 5E SL	P	1877	S	0.011	0.000	FEDERAL BUILDING	USA FOREST SERVICE	39.0994313214 -111.306348172
93-2402	Point to Point	S660 E1980 W4 11 20S 5E SL	P	1877	S	0.000	0.000	OGDEN UT 84401	USA FOREST SERVICE	39.0813287007 -111.329602984
93-2403	Point to Point	N660 E660 S4 02 20S 5E SL	P	1877	S	0.000	0.000	OGDEN UT 84401	USA FOREST SERVICE	39.0921602084 -111.325006689
93-2406	Point to Point	N660 E660 W4 02 20S 5E SL	P	1877	S	0.000	0.000	OGDEN UT 84401	USA FOREST SERVICE	39.0994250709 -111.334286966
93-2409	Point to Point	S660 W660 E4 01 20S 5E SL	P	1877	S	0.000	0.000	OGDEN UT 84401	USA FOREST SERVICE	39.095758433 -111.301770706
93-2424	Point to Point	N660 E1980 W4 01 20S 5E SL	P	1877	S	0.000	0.000	OGDEN UT 84401	USA FOREST SERVICE	39.0994163354 -111.311026675
93-2425	Point to Point	N660 E1980 W4 01 20S 5E SL	P	1877	S	0.000	0.000	OGDEN UT 84401	USA FOREST SERVICE	39.0994163354 -111.311026675
94-340	Point to Point	N660 W660 SE 24 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0485929481 -111.301715003
94-346	Point to Point	N660 E660 W4 21 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0559053709 -111.371369499
94-350	Point to Point	N660 W660 E4 24 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0558161735 -111.301727691
94-351	Point to Point	N660 E1980 W4 25 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0413794033 -111.310951292
94-352	Point to Point	S660 E1980 W4 26 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.037745751 -111.329514941
94-353	Point to Point	N660 E660 SW 23 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0485964478 -111.334156023
94-354	Point to Point	S660 W660 N4 22 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0594877539 -111.348147135
94-355	Point to Point	N660 W660 E4 10 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849273525 -111.338923992
94-356	Point to Point	S1980 E660 N4 10 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849046859 -111.343566048
94-357	Point to Point	S1980 E660 N4 10 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849046859 -111.343566048
94-361	Point to Point	N660 W660 SE 24 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0485929481 -111.301715003
94-362	Point to Point	S1980 E660 N4 24 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0558252565 -111.306319792
94-363	Point to Point	N660 W660 S4 13 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.063063784 -111.311001753

94-364	Point to Point	N660 W660 E4 14 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0703430846 -111.320311445
94-365	Point to Point	S660 E1980 W4 14 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0667624782 -111.329535431
94-366	Point to Point	S660 W660 E4 15 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0667357084 -111.338837181
94-367	Point to Point	N660 E660 W4 14 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0703746236 -111.334203398
94-368	Point to Point	N660 W660 S4 15 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0631131936 -111.348164937
94-369	Point to Point	S660 W660 N4 15 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0740681687 -111.348130247
94-370	Point to Point	S660 W660 NE 10 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.088541201 -111.33894978
94-371	Point to Point	N660 E660 W4 10 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849214184 -111.352825737
94-372	Point to Point	N660 W660 SE 09 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0776983905 -111.35741524
94-373	Point to Point	S660 W660 N4 16 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0741123634 -111.366671067
94-374	Point to Point	S660 W660 NE 09 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0884905742 -111.357522071
94-375	Point to Point	S660 W1980 E4 09 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0812673661 -111.362111322
94-376	Point to Point	S660 E660 W4 09 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0814123509 -111.371418185
94-377	Point to Point	S1980 E660 N4 10 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849046859 -111.343566048
94-378	Point to Point	S660 E660 NW 09 20S 5E SL	P	1879	S	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	39.0886587072 -111.371542561
94-379	Point to Point	N660 W660 SE 05 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0922691545 -111.376214115
94-380	Point to Point	N660 E660 W4 03 20S 5E SL	P	1879	S	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	39.0994250334 -111.352826812
94-381	Point to Point	S1980 E660 N4 04 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0994621753 -111.36199963
94-382	Point to Point	S660 W660 E4 04 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0957853959 -111.357461524
94-383	Point to Point	N660 W660 E4 04 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.099410811 -111.357479826
94-384	Point to Point	S660 E660 W4 03 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0957996173 -111.352808749
94-405	Point to Point	N660 E1980 W4 06 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0993370786 -111.405151569

94-406	Point to Point	N660 E1980 W4 06 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0993370786 -111.405151569
94-417	Point to Point	S1400 E1 NW 07 20S 5E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.0863792977 -111.412125431
94-418	Point to Point	S900 E600 NW 17 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0733659522 -111.389974015
94-419	Point to Point	S2400 E400 NW 07 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0836377514 -111.410703296
94-420	Point to Point	N1100 E1300 SW 07 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0787258433 -111.40754331
94-421	Point to Point	S1 E100 NW 18 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0756870101 -111.411754482
94-422	Point to Point	S2000 E1 NW 07 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0847313838 -111.412115842
94-423	Point to Point	N2700 W1000 SE 18 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0686777514 -111.395676149
94-424	Point to Point	N1950 E900 SW 19 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0521404009 -111.409064562
94-449	Point to Point	N2500 E1 SW 31 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0245746907 -111.41220788
93-2402	Point to Point	S660 W660 NE 12 20S 5E SL	P	1877	S	0.000 0.000	OGDEN UT 84401	USA FOREST SERVICE	39.0884586769 -111.301804891
94-360	Point to Point	N660 E660 S4 25 20S 5E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.0341535592 -111.306309108
94-361	Point to Point	N660 E1980 W4 25 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0413794033 -111.310951292
94-362	Point to Point	S660 E1980 W4 25 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0377539439 -111.310935409
94-363	Point to Point	N660 W660 S4 26 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0341112827 -111.329551474
94-364	Point to Point	S1980 E660 N4 27 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0413533907 -111.343444465
94-365	Point to Point	S660 E660 W4 23 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0521966249 -111.334149693
94-366	Point to Point	S660 E660 N4 21 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0596010333 -111.362083729
94-367	Point to Point	N660 E660 W4 21 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0559053709 -111.371369499
94-368	Point to Point	N660 W660 S4 15 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0631131936 -111.348164937
94-369	Point to Point	S660 W660 E4 16 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0668194817 -111.357440203
94-370	Point to Point	S660 W660 NE 20 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.059606161 -111.37598479

94-371	Point to Point	S660 E660 NW 21 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0596211195 -111.371334404
94-372	Point to Point	S660 W1980 E4 16 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0668050768 -111.36209107
94-373	Point to Point	S660 E660 NW 21 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0596211195 -111.371334404
94-374	Point to Point	S660 E1980 W4 17 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0667630055 -111.385120484
94-375	Point to Point	S660 E1980 W4 09 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0814271285 -111.366766363
94-376	Point to Point	S660 W660 N4 17 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0740809471 -111.385181376
94-377	Point to Point	S1980 E660 N4 10 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849046859 -111.343566048
94-378	Point to Point	N660 E660 W4 08 20S 5E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.0848508732 -111.38985723
94-379	Point to Point	S660 W660 NE 08 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0886437387 -111.376194856
94-380	Point to Point	N660 E1980 W4 08 20S 5E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.0848663865 -111.385205192
94-381	Point to Point	S660 W1980 E4 04 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0957709888 -111.362114296
94-383	Point to Point	S660 W660 E4 04 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0957853959 -111.357461524
94-384	Point to Point	S660 W660 E4 04 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0957853959 -111.357461524
94-385	Point to Point	S660 E660 N4 05 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1030043325 -111.380615651
94-386	Point to Point	N660 E1980 W4 08 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0848663865 -111.385205192
94-391	Point to Point	N660 E660 W4 05 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0993019041 -111.389945472
94-392	Point to Point	S660 W660 N4 08 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0885269168 -111.38537776
94-396	Point to Point	N660 E660 W4 08 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0848508732 -111.38985723
94-397	Point to Point	N660 E1980 W4 06 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0993370786 -111.405151569
94-398	Point to Point	S660 W660 N4 06 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.1029336684 -111.404500787
94-399	Point to Point	N660 E1980 W4 06 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0993370786 -111.405151569
94-402	Point to Point	N660 E1980 W4 06 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0993370786 -111.405151569

94-405	Point to Point	S660 E660 NW 08 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.088425073	-111.389908357
94-406	Point to Point	N660 E1980 W4 06 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0993370786	-111.405151569
94-415	Point to Point	S660 W660 N4 07 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0884068311	-111.404513775
94-416	Point to Point	S660 W660 N4 07 20S 5E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.0884068311	-111.404513775
94-417	Point to Point	S1900 E1500 NW 07 20S 5E SL	P	1879	S	0.000 0.000	324 25TH STREET	USA FOREST SERVICE	39.0850246473	-111.406834561
94-418	Point to Point	S2750 E1900 NW 17 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0683001459	-111.385365575
94-419	Point to Point	N1900 E2300 SW 07 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0809353688	-111.404031883
94-420	Point to Point	S100 W2600 NE 18 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0755247892	-111.401262282
94-421	Point to Point	S900 E1300 NW 18 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0732327861	-111.407511714
94-422	Point to Point	S1250 W1 NE 20 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0579931919	-111.373654583
94-423	Point to Point	N850 W1320 SE 18 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0635928165	-111.396775212
94-424	Point to Point	N1 E1250 SW 26 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.032315358	-111.332119634
94-442	Point to Point	S550 E2100 NW 35 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0308105277	-111.329119191
94-449	Point to Point	N2100 W1 SE 28 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.038043889	-111.35513165
94-461	Point to Point	N660 E1980 W4 17 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0703884332	-111.385140185
94-462	Point to Point	N400 E150 SW 33 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0188914506	-111.373182393
94-463	Point to Point	N1000 E50 SW 33 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0205382552	-111.373543162
94-467	Point to Point	S550 E3000 NW 29 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0452700828	-111.38164387
94-468	Point to Point	S1500 E1650 NW 29 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0426451426	-111.386384764
94-469	Point to Point	N1010 W1 SE 20 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0495180013	-111.373719028
94-460	Point to Point	S1 E1300 NW 35 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.032310365	-111.331943524
94-461	Point to Point	S660 W660 N4 07 20S 5E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0884068311	-111.404513775

94-467	Point to Point	S2600 E4400 NW 29 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.039655753	-111.376682746
94-468	Point to Point	N1300 E2400 SW 29 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0358928061	-111.383723554
94-469	Point to Point	N1300 W1900 SE 30 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0358417927	-111.398867429
94-576	Point to Point	S1980 E660 N4 10 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0849046859	-111.343566048
94-446	Surface	N2000 W800 SE 34 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0233256259	-111.33937014
94-447	Surface	S300 W2100 NE 34 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.031454287	-111.343913239
94-448	Surface	S450 W750 NE 33 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0310320716	-111.357734285
94-450	Surface	N2000 E1970 SW 28 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0377640998	-111.36675455
94-451	Spring	S2100 E1620 NW 33 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0264993197	-111.367928845
94-452	Surface	N1750 E1650 SW 33 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0226161633	-111.367920111
94-453	Surface	S350 E4300 NW 29 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0458343471	-111.377067794
94-454	Spring	N750 W450 SE 33 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0198398571	-111.356675048
94-457	Spring	S2350 E2750 NW 08 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0838079211	-111.382517187
94-464	Surface	S250 E2850 NW 20 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0606208652	-111.382067131
94-465	Surface	S1500 E2100 NW 20 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0571789697	-111.384690802
94-466	Surface	S2250 E3400 NW 20 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0551341375	-111.380099995
94-470	Spring	N850 E1400 SW 29 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0346451697	-111.387238644
94-471	Spring	N2000 E900 SW 30 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0378079056	-111.409112713
94-472	Spring	S1000 W1800 NE 31 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0295259343	-111.398479772
94-473	Spring	S450 W450 NE 31 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0310527497	-111.393734108
94-478	Spring	S750 E150 NW 32 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0302359268	-111.391616606
94-479	Spring	N200 E1880 SW 25 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.032876849	-111.31129742

94-596	Spring	N2250 W2200 SE 30 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0384473813	-111.399938685
94-597	Spring	S550 W2300 NE 30 20S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.045207254	-111.400312047
94-476	Point to Point	N1000 W1 SE 32 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0205376774	-111.37372274
94-481	Point to Point	N500 E1 SW 19 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0481467264	-111.412208256
94-484	Point to Point	N1900 E900 SW 19 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0520030739	-111.40906377
94-507	Point to Point	N1950 E900 SW 19 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0521404009	-111.409064562
94-513	Point to Point	S1 W2400 NE 19 20S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0612424571	-111.400567067

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Utah Division of Water Rights

Search of TOWNSHIP = '21S' and RANGE = '4E' and BEM = 'SL'

WR Number	Diversion Type	Well Log	Location	Status	Priority	Uses	CFS	ACFT	Address	Owner Name	Latitude	Longitude
63-2710	Point to Point		N660 E660 SW 21 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9637785255	-111.476556858
63-2711	Point to Point		N660 W660 SE 21 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.963735561	-111.462651144
63-2772	Point to Point		S660 W660 NE 18 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9888191353	-111.4998918
63-2880	Point to Point		N660 E660 S4 31 21S 4E SL	P	1893	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9349115495	-111.504118229
63-2881	Point to Point		S1980 E660 N4 16 21S 4E SL	P	1893	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9852029283	-111.467312915
63-2882	Point to Point		S660 W1980 E4 16 21S 4E SL	P	1893	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9816195086	-111.467297103
63-2883	Point to Point		N660 E660 S4 10 21S 4E SL	P	1893	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9925185004	-111.448682483
63-2884	Point to Point		S660 W660 N4 27 21S 4E SL	P	1893	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9601059692	-111.453370347
63-2885	Point to Point		N660 W660 E4 27 21S 4E SL	P	1893	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.956476981	-111.444142442
63-3361	Point to Point		N660 W660 SE 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9781052062	-111.481263056
63-3362	Point to Point		S660 W660 N4 16 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9888096426	-111.47198245
63-3363	Point to Point		N660 E1980 W4 16 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9852846519	-111.472003228
63-3364	Point to Point		S660 W1980 E4 16 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9816195086	-111.467297103
63-3365	Point to Point		N660 W660 S4 15 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9780234145	-111.453415184
63-3366	Point to Point		S1980 E660 N4 28 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.956515599	-111.467234331
63-3367	Point to Point		N660 W660 SE 16 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9780455472	-111.462663134
63-3368	Point to Point		N660 E1980 W4 22 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9709271553	-111.453368105
63-3369	Point to Point		S660 W1980 E4 21 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9672464855	-111.467277809
63-3370				P	1873	OS	0.015	0.000			38.9743979129	-111.453392055

	Point to Point	S660 W660 N4 22 21S 4E SL						324 25TH STREET	USA FOREST SERVICE		
63-3371	Point to Point	S660 E660 N4 22 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9744159369	-111.448747306
63-3372	Point to Point	S660 E1980 W4 15 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9816746978	-111.453361448
63-3373	Point to Point	S660 E1980 W4 15 21S 4E SL	P	1873	OS	0.000	0.200	324 25TH STREET	USA FOREST SERVICE	38.9816746978	-111.453361448
63-3374	Point to Point	N660 E1980 W4 15 21S 4E SL	P	1873	OS	0.000	0.100	324 25TH STREET	USA FOREST SERVICE	38.9853001948	-111.453384581
63-3375	Point to Point	S660 E660 NW 15 21S 4E SL	P	1873	OS	0.000	0.100	324 25TH STREET	USA FOREST SERVICE	38.98887452	-111.458018564
63-3376	Point to Point	S660 E660 NW 15 21S 4E SL	P	1873	OS	0.000	0.200	324 25TH AVENUE	USA FOREST SERVICE	38.98887452	-111.458018564
63-3377	Point to Point	N660 W660 SE 09 21S 4E SL	P	1873	OS	0.000	0.100	324 25TH STREET	USA FOREST SERVICE	38.9924816059	-111.462687873
63-3378	Point to Point	N660 W660 SE 16 21S 4E SL	P	1873	OS	0.100	0.000	324 25TH STREET	USA FOREST SERVICE	38.9780455472	-111.462663134
63-3379	Point to Point	N660 E1980 W4 16 21S 4E SL	P	1873	OS	0.000	0.100	324 25TH STREET	USA FOREST SERVICE	38.9852846519	-111.472003228
63-3380	Point to Point	S660 E660 W4 15 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9816564862	-111.45800667
63-3381	Point to Point	S660 E660 N4 16 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9888284143	-111.467336766
63-3382	Point to Point	S660 E660 NW 15 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.98887452	-111.458018564
63-3383	Point to Point	N660 E660 SW 10 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9925000096	-111.458041942
63-3385	Point to Point	N660 W660 S4 30 21S 4E SL	P	1873	OS	0.000	0.200	324 25TH STREET	USA FOREST SERVICE	38.9493458122	-111.508707844
63-3386	Point to Point	S660 E1980 W4 32 21S 4E SL	P	1873	OS	0.000	0.200	324 25TH STREET	USA FOREST SERVICE	38.9385897439	-111.490397861
63-3387	Point to Point	S660 W660 N4 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9887911489	-111.490596212
63-3388	Point to Point	S660 E660 NW 28 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9601530295	-111.476532556
63-3389	Point to Point	N660 E660 W4 29 21S 4E SL	P	1873	OS	0.000	0.200	324 25TH STREET	USA FOREST SERVICE	38.2610861657	-111.503541141
63-3390	Point to Point	N660 E660 W4 32 21S 4E SL	P	1873	OS	0.000	0.100	324 25TH STREET	USA FOREST SERVICE	38.9421955803	-111.495065463
63-3391	Point to Point	N660 W660 S4 29 21S 4E SL	P	1873	OS	0.000	0.200	324 25TH STREET	USA FOREST SERVICE	38.9493387444	-111.490421853
63-3392	Point to Point	S660 E660 NW 28 21S 4E SL	P	1873	OS	0.000	0.200	324 25TH STREET	USA FOREST SERVICE	38.9601530295	-111.476532556

63-3393	Point to Point	S660 E1980 W4 32 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9385897439 -111.490397861
63-3394	Point to Point	N660 E660 S4 09 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9924538981 -111.467360622
63-3395	Point to Point	S660 E660 N4 16 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9888284143 -111.467336766
63-3396	Point to Point	S660 W660 N4 16 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9888096426 -111.47198245
63-3397	Point to Point	N660 E660 S4 09 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9924538981 -111.467360622
63-3398	Point to Point	N660 W660 SE 09 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9924816059 -111.462687873
63-3399	Point to Point	S660 W660 NE 16 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9888561192 -111.462664257
63-3400	Point to Point	N660 E1980 W4 31 21S 4E SL	P	1873	OS	0.000 0.200	324 25TH STREET	USA FOREST SERVICE	38.9421016905 -111.508475016
63-3403	Point to Point	S660 W660 NE 07 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	39.0032767833 -111.499989214
63-3404	Point to Point	N660 E1980 W4 16 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9852846519 -111.472003228
63-3405	Point to Point	S660 W660 NE 17 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9887624221 -111.481300623
63-3406	Point to Point	S660 W660 NE 20 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9744797223 -111.4812385
63-3407	Point to Point	S660 E660 W4 16 21S 4E SL	P	1873	OS	0.000 0.200	324 25TH STREET	USA FOREST SERVICE	38.981640214 -111.47662435
63-3408	Point to Point	S660 E660 W4 16 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.981640214 -111.47662435
63-3409	Point to Point	N660 E1980 W4 16 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9852846519 -111.472003228
63-3410	Point to Point	S660 E660 NW 16 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9887815647 -111.476654949
63-3507	Point to Point	N660 E660 W4 07 21S 4E SL	P	1873	OS	0.000 0.100	324 25TH STREET	USA FOREST SERVICE	38.9997788355 -111.513087333
63-3510	Point to Point	N660 W660 S4 07 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9925183155 -111.508884401
63-3511	Point to Point	S660 W660 N4 18 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9888928597 -111.508858418
63-3513	Point to Point	N660 E660 W4 18 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9853717333 -111.513124498
63-3514	Point to Point	S1980 E660 N4 18 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9852876477 -111.504187136
63-3515	Point to Point	N660 E660 SW 08 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9924644836 -111.495271422

63-3516	Point to Point	N660 W660 SE 07 21S 4E SL	P	1873	OS	0.015	0.000	324 36TH STREET	USA FOREST SERVICE	38.9924445978 -111.499917325
63-3517	Point to Point	N660 E660 SW 18 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.978131505 -111.513043333
63-3519	Point to Point	N660 E1980 W4 07 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9997992607 -111.508441081
63-3520	Point to Point	N660 W660 SE 07 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9924445978 -111.499917325
63-3521	Point to Point	S660 W660 N4 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9887911489 -111.490596212
63-3522	Point to Point	N660 E660 S4 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9781584172 -111.485802628
63-3523	Point to Point	N660 E660 W4 20 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9709871533 -111.495000477
63-3524	Point to Point	S660 E660 NW 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.988839018 -111.495246135
63-3525	Point to Point	S660 W1980 E4 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9816017543 -111.485914755
63-3526	Point to Point	S660 W660 E4 18 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9816827883 -111.499749204
94-1131	Point to Point	S2450 E100 NW 34 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9406958709 -111.459931768
94-1133	Point to Point	S2450 E800 NW 34 21S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9407055805 -111.457469818
94-1392	Point to Point	S200 E1100 NW 14 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9901800165 -111.437759808
94-1396	Point to Point	N1750 E2100 SW 10 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9955136518 -111.452992743
94-25	Point to Point	S2450 E800 NW 34 21S 4E SL	P	19410124	D	0.006	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9407055805 -111.457469818
94-476	Point to Point	S550 E2100 W4 02 21S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0099688278 -111.434240768
94-486	Point to Point	N100 W800 SE 05 21S 4E SL	P	1879	S	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	39.0053556172 -111.481949961
94-496	Point to Point	S1700 E450 NW 05 21S 4E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0128992631 -111.496089814
63-3393	Point to Point	N660 W660 SE 31 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.934971024 -111.499732461
63-3394	Point to Point	S660 W1980 E4 32 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9385596433 -111.485758942
63-3395	Point to Point	N660 E660 SW 15 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9780639421 -111.458018151
63-3396	Point to Point		P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9673016492 -111.453344984

		S660 E1980 W4 22 21S 4E SL								
63-3404	Point to Point	S660 W660 N4 21 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9744502574 -111.471939015
63-3405	Point to Point	N660 W660 E4 28 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9564813874 -111.462655712
63-3520	Point to Point	S660 E660 W4 18 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9817462762 -111.513098306
63-3532	Point to Point	S660 W1980 E4 19 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9673217639 -111.504263641
63-3536	Point to Point	N660 E660 SW 28 21S 4E SL	P	1873	OS	0.015 0.000	324 25TH STREET	USA FOREST SERVICE	38.9493154386 -111.476516946
94-1131	Point to Point	N1 W510 SE 33 21S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9328664803 -111.461968713
94-1133	Point to Point	S2450 E100 NW 34 21S 4E SL	P	1879	S	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9406958709 -111.459931768
94-1392	Point to Point	S2200 W1050 NE 13 21S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9847836717 -111.406093357
94-1396	Point to Point	N1150 W2280 SE 24 21S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9650259162 -111.412778391
94-110	Spring	N320 E150 SW 11 21S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9915955993 -111.441112238
94-111	Spring	S200 E1080 NE 14 21S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9902300898 -111.419297048
94-112	Spring	N2400 E2250 SW 23 21S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9685444236 -111.433926902
94-113	Spring	S2250 W130 NE 23 21S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9700301833 -111.423678221
94-1130	Spring	S1750 E800 NW 34 21S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9426282052 -111.457482179
94-1132	Spring	S1900 E900 NW 34 21S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9422175971 -111.457127816
94-114	Spring	S465 W1277 N4 26 21S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9606185566 -111.437024219
94-115	Surface	S533 E1074 N4 25 21S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9604483701 -111.410220577
94-117	Spring	N48 E2268 W4 26 21S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9548349449 -111.433831887
94-118	Spring	S1570 W43 N4 26 21S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9575997925 -111.432664447
94-120	Surface	S157 W589 E4 35 21S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9396506242 -111.425359967

94-121	Spring	S798 E1099 N4 34 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9452470216 -111.447192255
94-122	Spring	N1060 W961 S4 35 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9357630228 -111.435944851
94-123	Surface	N782 W1124 SE 35 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9349549803 -111.427288267
94-124	Spring	N346 E1078 S4 36 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9337780947 -111.410289363
94-126	Spring	S332 W1891 E4 27 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9537357226 -111.448455752
94-1386	Surface	S3400 W400 NE 13 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9814957126 -111.4037871
94-1387	Spring	S1250 W1050 NE 26 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9584548001 -111.426949754
94-1388	Spring	S850 W1150 NE 26 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9595521524 -111.42730815
94-1389	Spring	S2400 E1600 NW 35 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9408527409 -111.43614804
94-1390	Spring	N80 W1490 SE 23 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9621020973 -111.428519666
94-1391	Spring	N1200 E1700 SW 32 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9364895357 -111.49144313
94-1393	Spring	S1900 E2400 NW 14 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9855279511 -111.433155939
94-1394	Surface	S1750 W50 NE 24 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9713802328 -111.404933961
94-1395	Spring	S1300 W1500 NE 34 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9438326109 -111.447069988
94-1397	Spring	S2150 W100 NE 14 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9848591559 -111.423418205
94-1399	Spring	S600 W2100 NE 35 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9456821371 -111.430635986
94-1400	Spring	N1850 E2100 SW 10 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9957883101 -111.452994495
94-1401	Surface	S200 W2300 NE 35 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9467781762 -111.431346111
94-1403	Surface	N2350 W2350 SE 15 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9826194105 -111.450143626
94-1404	Surface		P	1879	OS	0.000	0.000			38.9903026703 -111.451023716

		S150 E2650 NW 15 21S 4E SL						324 - 25TH STREET	USA FOREST SERVICE		
94-1405	Surface	N200 W2300 SE 10 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9912329554	-111.449733187
94-1406	Surface	N1050 W1900 SE 10 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9935729941	-111.448340087
63-3527	Point to Point	N660 W660 E4 18 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9853082555	-111.499774715
63-3528	Point to Point	S660 W1980 E4 18 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9816627233	-111.504394302
63-3529	Point to Point	S660 W1980 E4 18 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9816627233	-111.504394302
63-3531	Point to Point	N660 E1980 W4 17 21S 4E SL	P	1873	OS	0.000	0.200	324 25TH STREET	USA FOREST SERVICE	38.9853478227	-111.490483841
63-3532	Point to Point	S660 E660 NW 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.988839018	-111.495246135
63-3533	Point to Point	S660 E660 W4 21 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9673259465	-111.476563153
63-3534	Point to Point	S660 E660 NW 28 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9601530295	-111.476532556
63-3535	Point to Point	N660 E660 W4 28 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9565469866	-111.476536896
63-3536	Point to Point	S660 E660 W4 21 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9673259465	-111.476563153
63-3537	Point to Point	N660 W660 E4 20 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9709323079	-111.481231966
63-3538	Point to Point	N660 E660 W4 21 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9709514379	-111.476587463
63-3539	Point to Point	S660 W660 NE 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9887624221	-111.481300623
63-3540	Point to Point	S660 E660 N4 17 21S 4E SL	P	1873	OS	0.015	0.000	324 25TH STREET	USA FOREST SERVICE	38.9888106616	-111.485950542
63-2771	Surface	S1150 E1790 NW 20 21S 4E SL	P	1873	OS	0.006	0.000	115 EAST 900 NORTH	USA FOREST SERVICE	38.9732373309	-111.490976444
t41643	Surface	N840 W1140 SE 15 21S 4E SL	A	20160504	O	0.000	6.000	225 NORTH 5TH STREET SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.9784884687	-111.445859421
t41643	Surface	N1480 W1050 SW 24 21S 4E SL	A	20160504	O	0.000	6.000	225 NORTH 5TH STREET SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.9659530479	-111.426994766
t41643	Surface	N1280 W950 SE 11 21S 4E SL	A	20160504	O	0.000	6.000	225 NORTH 5TH STREET SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.9942690478	-111.426466131

t41643	Surface	S2170 W1320 NE 13 21S 4E SL	A	20160504	O	0.000	6.000	225 NORTH 5TH STREET SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.9848627444 -111.407044036
94-1407	Surface	N1100 E1950 SW 10 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9937263133 -111.453509313
94-1408	Surface	N550 E2250 SW 10 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9922198078 -111.452443778
94-1409	Surface	N100 E1950 SW 10 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9909797289 -111.453491777
94-1410	Spring	N1700 W1700 SE 23 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9665488777 -111.429285335
94-1411	Spring	S1600 E2300 NW 23 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9718325697 -111.433713313
94-1412	Spring	N1850 E900 SW 14 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9812898492 -111.438697871
94-1413	Spring	N2050 E350 SW 14 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9818318459 -111.440636781
94-1414	Spring	S2000 W2000 NE 15 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9851945421 -111.448639151
94-1415	Spring	S1200 W2000 NE 15 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9873918137 -111.448653026
94-218	Spring	N1013 W838 S4 10 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9934675642 -111.45396111
94-477	Spring	S1100 W1950 NE 12 21S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0020810762 -111.409338352
94-480	Spring	S150 W1900 NE 12 21S 4E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0046909311 -111.409177375
94-834	Surface	S2480 W20 NE 33 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.940611803 -111.460353284
94-835	Surface	N667 W212 SE 33 21S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9346998807 -111.460932593
94-836	Surface	S2540 E820 NW 34 21S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9404586625 -111.457397888
a36193	Spring	S2000 W2000 NE 15 21S 4E SL	A	20100114	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9851945421 -111.448639151

Utah Division of Water Rights

Search of TOWNSHIP = '21S' and RANGE = '5E' and BEM = 'SL'

WR Number	Diversion Type	Well Log	Location	Status	Priority	Uses	CFS	ACFT	Address	Owner Name	Latitude	Longitude
94-440	Point to Point		N1 E2220 SW 11 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9970521304	111.327429583
94-441	Point to Point		S850 W2580 NE 15 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9946658398	-111.344313899
94-442	Point to Point		S1850 E1350 NW 15 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9919682456	-111.349002645
94-443	Point to Point		S1900 E1 NW 15 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9918165408	-111.353749988
94-462	Point to Point		S1000 E880 NW 04 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0150516039	-111.369378278
94-463	Point to Point		N1 W300 SE 05 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0114844695	-111.373409832
94-474	Point to Point		S2800 E1450 NW 08 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0036865642	-111.385791178
94-475	Point to Point		S2600 W1000 NE 07 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.004206904	-111.394418798
94-116	Surface		S465 E1379 W4 30 21S 5E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9594230649	-111.399890659
94-119	Surface		S1233 E475 W4 31 21S 5E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9429204494	-111.403058346
94-1593	Spring		N1197 W1041 E4 31 21S 5E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9495609418	-111.394568082
94-428	Spring		N500 W2050 SE 23 21S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.969407036	-111.323844619
94-429	Spring		N180 E680 SW 23 21S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9685567757	-111.332820989
94-430	Surface		S2000 W1600 NE 27 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.962545815	-111.340814521
94-431	Surface		S110 W950 NE 21 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9822414698	-111.357118096

94-432	Surface	N1000 W1800 SE 15 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9852560005	-111.341557875
94-433	Surface	N1850 W700 SE 15 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9876019689	-111.337697685
94-434	Surface	N500 W2200 SE 16 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9839032993	-111.361525585
94-435	Surface	S1200 W2050 NE 16 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9937169545	-111.360978564
94-436	Surface	N187 W1910 SE 09 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9975280552	-111.360505114
94-437	Surface	S350 W490 NE 11 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0105040514	-111.318429466
94-438	Surface	S1150 W2100 NE 11 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0082910968	-111.324087605
94-439	Surface	S4100 E2150 NW 10 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0002499739	-111.346141609
94-444	Surface	S1650 E620 NW 10 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0069628875	-111.351560624
94-445	Spring	S650 W720 NE 09 21S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0096950729	-111.356291748
94-455	Surface	S1500 E1700 NW 05 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0135522569	-111.384961684
94-456	Spring	S2100 E220 NW 08 21S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0055946941	-111.390131625
94-458	Spring	S3350 E550 NW 09 21S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0022903045	-111.370369308
94-459	Spring	N450 E2950 SW 08 21S 5E SL	P	1879	S	0.011	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9982133961	-111.380576004
94-583	Surface	N1600 E1200 SW 27 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.957998638	-111.34954813
94-584	Surface	N1650 W1900 SE 28 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9581026372	-111.360454546
94-585	Surface	S650 E250 NW 28 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9662500158	-111.371446826

94-586	Surface	N500 E400 SW 21 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9694103291	-111.370935534
94-587	Surface	N1000 E1650 SW 20 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9707103989	-111.385141624
94-588	Surface	S700 E3000 NW 20 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9805560174	-111.380397906
94-589	Surface	N600 W2000 SE 21 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9696718112	-111.360818474
94-940	Point to Point	S660 W660 N4 35 21S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9517361541	-111.328240767
94-440	Point to Point	S900 W1880 NE 03 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0153291211	-111.341976794
94-441	Point to Point	S1150 E1000 NW 15 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9938871746	-111.350243996
94-443	Point to Point	S1100 E900 NW 15 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9940234433	-111.350596649
94-460	Point to Point	S500 W1 NE 01 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0164702066	-111.298104569
94-474	Point to Point	N800 E500 SW 05 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0135630357	-111.389189577
94-475	Point to Point	N300 W350 SE 06 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0121796876	-111.392174608
94-940	Point to Point	S660 W660 E4 35 21S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9445708596	-111.318964123
a25549	Point to Point	N660 E660 W4 15 21S 5E SL	A	20061103	S	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	38.991614313	-111.351463971
a25549	Surface	S3520 E135 NW 10 21S 5E SL	A	20061103	S	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	39.0018216144	-111.353242486
t41643	Surface	N2260 E1170 SW 01 21S 5E SL	A	20160504	O	0.000	6.000	225 NORTH 5TH STREET SUITE 900	CANYON FUEL COMPANY, L.L.C.	39.0176884999	-111.312616813
t41775	Surface	N785 E1804 W4 11 21S 5E SL	A	20160615	X	0.000	15.870	225 NORTH 5TH STREET SUITE 900	CANYON FUEL COMPANY, L.L.C.	39.0064147276	-111.328937564
94-590	Surface	S1650 E700 NW 21 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9780078034	-111.369843837
94-591	Spring		P	1879	S	0.011	0.000			38.9729908375	-111.31911057

		N1800 W700 SE 23 21S 5E SL						324 - 25TH STREET	USA FOREST SERVICE	
94-592	Surface	S400 E150 NW 09 21S 5E SL	P	1879	S	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	39.0103881793 -111.371819784
a38625	Spring	S615 W2075 SE 03 21S 5E SL	A	20121214	S	0.050	2.810	324 - 25TH STREET	USA FOREST SERVICE	39.0097433671 -111.342609739

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Utah Division of Water Rights

Search of TOWNSHIP = '22S' and RANGE = '4E' and BEM = 'SL'

WR Number	Diversion Type	Well Log	Location	Status	Priority	Uses	CFS	ACFT	Address	Owner Name	Latitude	Longitude
94-1199	Point to Point		N660 E660 S4 33 22S 4E SL	P	1879	S	0.011	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8481233408	-111.466445018
94-1200	Point to Point		S660 E660 W4 33 22S 4E SL	P	1879	S	0.011	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8518018748	-111.475917422
94-1201	Point to Point		N660 W660 E4 33 22S 4E SL	P	1879	S	0.011	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8559074499	-111.46191643
94-1202	Point to Point		S660 W660 NE 33 22S 4E SL	P	1879	S	0.000	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8595084397	-111.462066524
94-1203	Point to Point		S660 W660 NE 33 22S 4E SL	P	1879	S	0.000	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8595084397	-111.462066524
94-1204	Point to Point		S660 W1980 E4 28 22S 4E SL	P	1879	S	0.000	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8666896191	-111.466837295
94-1205	Point to Point		N660 W660 E4 28 22S 4E SL	P	1879	S	0.000	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8703336836	-111.462223094
94-1206	Point to Point		S660 W660 NE 28 22S 4E SL	P	1879	S	0.011	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.87390779	-111.462332718
94-1207	Point to Point		N660 E1980 W4 21 22S 4E SL	P	1879	S	0.000	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8844837729	-111.471825159
94-1208	Point to Point		N660 E1980 W4 21 22S 4E SL	P	1879	S	0.011	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8844837729	-111.471825159
94-1209	Point to Point		N660 E660 S4 16 22S 4E SL	P	1879	S	0.011	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8916980916	-111.467200859
94-1219	Point to Point		S660 E660 N4 20 22S 4E SL	P	1879	S	0.011	0.000	466 SOUTH MAIN	WINTCH & COMPANY LIMITED	38.8879559933	-111.485746454
94-135	Point to Point		N400 E2600 SW 11 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9060219087	-111.432811484
94-136				P	1879	OS	0.000	0.000	324 - 25TH STREET		38.9030672862	-111.444253406

	Point to Point	S660 W660 NE 15 22S 4E SL						USA FOREST SERVICE	
94-1576	Point to Point	S660 W1980 E4 22 22S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8813229792 -111.448843168
94-1578	Point to Point	S660 W660 NE 15 22S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9030672862 -111.444253406
94-1579	Point to Point	S660 W660 N4 27 22S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8740786556 -111.453255204
94-1580	Point to Point	S660 E1980 W4 13 22S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8958979978 -111.416408772
94-1581	Point to Point	S660 E660 NW 34 22S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8595267469 -111.457429299
94-1582	Point to Point	S660 E660 N4 34 22S 4E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8595389416 -111.448502451
94-1586	Point to Point	N1072 W103 SE 24 22S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.878859876 -111.405228403
94-1594	Point to Point	S619 W586 E4 01 22S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9244079637 -111.406880395
94-296	Point to Point	N1320 W660 S4 09 22S 4E SL	P	1900	S	0.015 0.000	C/O ACORD LAKES MTN RETREAT,255 W 800 S, SLC 84101	HANSEN LAND AND LIVESTOCK COMPANY	38.9080003755 -111.4719079
94-297	Point to Point	N660 E660 W4 16 22S 4E SL	P	1900	S	0.011 0.000	C/O: JOHN BUSHNELL, 2028 E 7000 S, SLC 84121	ACORD LAKES MOUNTAIN RETREAT	38.8989012645 -111.476462498
94-1594	Point to Point	N522 E423 S4 12 22S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9063627337 -111.412635984
94-1595	Point to Point	S266 E17 NE 33 22S 4E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8606000283 -111.459695157
94-101	Rediversion	S350 E300 N4 16 22S 4E SL	P	19730126	DS	0.015 0.000	ATTN: JOHN BUSHNELL	ACORD LAKES MOUNTAIN RETREAT	38.9034271584 -111.468502908
94-101	Surface	S1500 E450 N4 16 22S 4E SL	P	19730126	DS	0.015 0.000	ATTN: JOHN BUSHNELL	ACORD LAKES MOUNTAIN RETREAT	38.900270666 -111.46795488
94-125	Spring	N1550 W450 SE 01	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9236760758 -111.406438371

		22S 4E SL									
94-127	Surface	S908 W35 N4 02 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9303698361	-111.432655407
94-128	Surface	S1498 E859 N4 03 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9287899407	-111.448100135
94-129	Surface	S961 E1316 W4 03 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9235031164	-111.455885182
94-130	Surface	N1189 W708 S4 03 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9226491805	-111.453767763
94-134	Surface	S2530 E400 NW 10 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9124269019	-111.459086628
94-137	Surface	S1742 W175 N4 14 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.900114351	-111.433240607
94-138	Spring	S890 W563 E4 15 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.895196179	-111.443897993
94-139	Surface	N125 E852 SW 15 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8907457118	-111.457254889
94-140	Surface	N344 W826 S4 22 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8768340081	-111.453856039
94-1402	Spring	N800 W1490 SE 11 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9070910643	-111.428615436
94-141	Surface	N1735 E858 S4 22 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8806775068	-111.447962611
94-142	Spring	S698 E929 W4 26 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8667310411	-111.438611294
94-143	Spring	S380 E90 NW 34 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8602879246	-111.459436689
94-144	Spring	S484 W1000 NE 27 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8745744707	-111.445374388
94-145	Surface	N430 E317 SW 25 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8625722767	-111.422299146
94-146	Spring		P	1879	OS	0.015	0.000	324 - 25TH STREET		38.8622137191	-111.422708083

		N300 E200 SW 25 22S 4E SL							USA FOREST SERVICE		
94-147	Surface	N1266 W1237 S4 35 22S 4E SL	P	1879	OS	0.000	0.000	324 25TH STREET	USA FOREST SERVICE	38.850337307	-111.436980076
94-155	Spring	S1750 W2150 NE 27 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8710816893	-111.449393351
94-1583	Spring	N962 E785 SW 27 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8639835329	-111.457018699
94-1584	Spring	N1245 E870 SW 27 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8647620012	-111.456725046
94-1585	Surface	S73 E113 NW 34 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8611314668	-111.459361321
94-1587	Surface	S236 E536 N4 34 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8607018407	-111.448945393
94-1588	Spring	S2038 W429 N4 35 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8557678904	-111.434128738
94-1589	Spring	S671 E504 NW 26 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8740809425	-111.440086462
94-1590	Spring	N1275 E972 SW 27 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8648458056	-111.456367211
94-1591	Surface	S1193 W1078 E4 34 22S 4E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8508226117	-111.445644229
94-1596	Spring	S1226 W753 N4 24 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.887083352	-111.416755317
94-1597	Spring	N215 W2230 E4 23 22S 4E SL	P	1879	OSPX	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.883738903	-111.431219806
94-1599	Surface	N2580 W125 SE 16 22S 4E SL	P	1900	DIS	0.015	0.000	C/O JOHN BUSHNELL	ACORD LAKES MOUNTAIN RETREAT	38.8970156172	-111.460717388
94-1599	Surface		P	1900	DIS	0.015	0.000			38.8965228238	-111.460309981

			N2400 W10 SE 16 22S 4E SL						C/O JOHN BUSHNELL	ACORD LAKES MOUNTAIN RETREAT		
94-1600	Surface		N570 E250 S4 09 22S 4E SL	P	1879	S	0.015	0.000	C/O ACORD LAKES MOUNTAIN RETREAT	HANSEN LAND AND LIVESTOCK COMPANY	38.9059533403	-111.468695292
94-1881	Underground		N1557 E857 S4 08 22S 4E SL	A	20060824	DIS	0.000	2.000	976 N 2500 W	DANIEL J. & TAMMY L. DWYER	38.9085481587	-111.484952079
94-1885	Underground	431950	N129 W470 E4 16 22S 4E SL	P	20080701	D	0.000	0.250	1383 FARMERS FREEWAY	LANE R. AND LOREEN SORENSEN	38.8975282797	-111.461956449
94-1890	Surface		S200 W100 E4 16 22S 4E SL	P	20090317	D	0.015	0.250	244 NORTH 200 EAST	MELVIN J. RIDER	38.8966297961	-111.460650084
94-1893	Underground		N660 E1320 SW 08 22S 4E SL	A	20100208	DIS	0.000	1.730	PO BOX 38	LEON P. AND VIRGINIA A. CHRISTENSEN FAMILY TRUST	38.9060121831	-111.492487904
94-1903	Spring		N1140 E1491 SW 12 22S 4E SL	A	20140522	X	0.041	29.970	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY LC	38.9080630598	-111.41814144
94-1903	Spring		N1205 E1673 SW 12 22S 4E SL	A	20140522	X	0.041	29.970	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY LC	38.9082438895	-111.417502677
94-264	Spring		N1105 W1275 S4 35 22S 4E SL	P	1879	OS	0.015	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8498945921	-111.437110844
94-298	Surface		N2100 W930 SE 16 22S 4E SL	P	1900	DS	0.067	0.000	C/O JOHN BUSHNELL, 2028 E 7000 S, SLC, 84121	ACORD LAKES MOUNTAIN RETREAT	38.8956860023	-111.46353831
94-298	Rediversion		S750 W200 NE 16 22S 4E SL	P	1900	DS	0.067	0.000	C/O JOHN BUSHNELL, 2028 E 7000 S, SLC, 84121	ACORD LAKES MOUNTAIN RETREAT	38.9023672097	-111.461061765
94-299	Rediversion		S350 E300 N4 16 22S 4E SL	P	1900	DS	0.007	0.000	C/O JOHN BUSHNELL, 2028 EAST 7000 S, SLC 84121	ACORD LAKES MOUNTAIN RETREAT	38.9034271584	-111.468502908
94-299	Surface		S1500 E450 N4 16 22S 4E SL	P	1900	DS	0.007	0.000	C/O JOHN BUSHNELL, 2028 EAST 7000 S, SLC 84121	ACORD LAKES MOUNTAIN RETREAT	38.900270666	-111.46795488
94-302	Surface		S1500 W100 NE 04 22S 4E SL	P	1899	S	0.015	0.000	C/O JOHN BUSHNELL	ACORD LAKES MOUNTAIN RETREAT	38.9292618006	-111.460849637
63-2478	Underground		N1737 E1166 S4 06 22S 4E SL	P	1900	D	0.040	7.310	365 COBBLE LANE	CAMP ESTATE	38.9234464127	-111.502165519
94-87	Surface		N1140 E1491	P	19710614	X	0.070	0.000	ATTN: PROPERTY ADMINISTRATION	CANYON FUEL	38.9080630598	-111.41814144

		SW 12 22S 4E SL						COMPANY LLC	
94-87	Surface	N1205 E1673 SW 12 22S 4E SL	P	19710614 X	0.070	0.000	ATTN: PROPERTY ADMINISTRATION	CANYON FUEL COMPANY LLC	38.9082438895 -111.417502677
94-99	Underground	S2130 W1200 NE 05 22S 4E SL	P	19730126 D	0.023	0.000	A UTAH LIMITED PARTNERSHIP	ACORD LAKES MOUNTAIN RETREAT	38.9274491017 -111.483349627
a12263	Surface	S2300 0 N4 07 22S 4E SL	A	19820429 D	0.040	0.000	BOX 213	HOWARD NIELSEN	38.9123406432 -111.50618646
a12263	Surface	N2180 E175 S4 19 22S 4E SL	A	19820429 D	0.040	0.000	BOX 213	HOWARD NIELSEN	38.881139347 -111.505909197
a12263	Surface	N1810 E380 S4 06 22S 4E SL	A	19820429 D	0.040	0.000	BOX 213	HOWARD NIELSEN	38.9236349494 -111.504930606
a12263	Surface	S800 E1200 NW 05 22S 4E SL	A	19820429 D	0.040	0.000	BOX 213	HOWARD NIELSEN	38.9309804353 -111.493036506
E2118	Underground	S1820 W240 N4 18 22S 4E SL	A	19820810 O	0.000	7.250	P.O. BOX 213	HOWARD W. NIELSEN	38.8990300866 -111.50697024
E2119	Underground	S1820 W240 N4 18 22S 4E SL	A	19820810 O	0.460	72.500	37 NORTH 100 EAST	MARLIN JR. SORENSON	38.8990300866 -111.50697024

Search of TOWNSHIP = '22S' and RANGE = '5E' and BEM = 'SL'

WR Number	Diversion Type	Well Log	Location	Status	Priority	Uses	CFS	ACFT	Address	Owner Name	Latitude	Longitude
94-1030	Point to Point		S660 E1980 W4 09 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9156183592	-111.365884731
94-1031	Point to Point		N660 E660 W4 20 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8902358103	-111.389518177
94-1032	Point to Point		N660 W660 SE 17 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8974824918	-111.375382745
94-1033	Point to Point		S660 E1980 W4 17 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9011170238	-111.384603082
94-1034	Point to Point		S1980 E660 N4 20 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8902296236	-111.38002232
94-1035	Point to Point		S1980 E660 N4 21 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8901671993	-111.361439704
94-1036	Point to Point		S660 E660 W4 21 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8866258903	-111.370916944
94-1060	Point to Point		S660 E660 W4 15 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.900976425	-111.352181718
94-1077	Point to Point		N660 E660 W4 33 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8607748779	-111.370880824
94-1078	Point to Point		S660 W660 E4 33 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8570259822	-111.356970867
94-1079	Point to Point		S1980 E660 N4 33 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8610142103	-111.361632198
94-1081	Point to Point		S660 W660 N4 33 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8646253283	-111.366288166
94-1082	Point to Point		S660 W660 N4 33 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8646253283	-111.366288166
94-1083	Point to Point		S660 E660 W4	P	1879	S	0.000	0.000	125 SOUTH	PRICE FIELD OFFICE USA	38.8716437484	-111.333880369

		26 22S 5E SL					600 WEST	BUREAU OF LAND MANAGEMENT		
94-1084	Point to Point	S660 W1980 E4 26 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8713459578	-111.324473938
94-1085	Point to Point	N660 W660 SE 28 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8681536	-111.35703817
94-1086	Point to Point	S660 W660 NE 28 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8791981191	-111.35724327
94-1087	Point to Point	N660 E660 W4 15 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9046020299	-111.352199615
94-1088	Point to Point	S660 W660 E4 15 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9008601011	-111.33824764
94-1090	Point to Point	N660 E660 S4 21 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8829221149	-111.361875571
94-1102	Point to Point	N660 W660 SE 12 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9115951304	-111.30082822
94-1116	Point to Point	S660 W660 N4 23 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8934522243	-111.328964374
94-1117	Point to Point	S660 W660 N4 24 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8933680942	-111.310305543
94-1185	Point to Point	N660 E660 S4 15 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8972447409	-111.342949243
94-1186	Point to Point	N660 W660 SE 15 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8971366251	-111.338328364
94-1187	Point to Point	S660 E660 N4 23 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8934652619	-111.324324859
94-1188	Point to Point	S660 E660 N4 23 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8934652619	-111.324324859
94-1189	Point to Point	N660 E1980 W4 24 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET,	CANYON FUEL COMPANY, L.L.C.	38.8897119004	-111.310604779

								SUITE 900		
94-1218	Point to Point	N660 W660 SE 15 22S 5E SL	P	1879	S	0.000	0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8971366251 -111.338328364
94-1289	Point to Point	S660 W660 N4 16 22S 5E SL	P	1879	S	0.000	0.000	675 EAST 500 SOUTH, 5TH FLOOR	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.	38.9082961379 -111.366004855
94-1290	Point to Point	N660 E660 SW 16 22S 5E SL	P	1879	S	0.000	0.000	675 EAST 500 SOUTH, 5TH FLOOR	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.	38.8974973754 -111.370742988
94-1291	Point to Point	N660 E660 SW 16 22S 5E SL	P	1879	S	0.000	0.000	675 EAST 500 SOUTH, 5TH FLOOR	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.	38.8974973754 -111.370742988
94-1292	Point to Point	N660 W660 S4 16 22S 5E SL	P	1879	S	0.000	0.000	675 EAST 500 SOUTH, 5TH FLOOR	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.	38.8974038956 -111.366116189
94-1595	Point to Point	N243 W72 E4 19 22S 5E SL	P	1879	OS	0.000	0.000	324 - 25TH STREET	USA FOREST SERVICE	38.8890818066 -111.392084574
94-1030	Point to Point	N660 W660 S4 09 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9119217311 -111.366023464
94-1031	Point to Point	S660 E660 N4 20 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8938552207 -111.380041632
94-1032	Point to Point	N660 W660 SE 17 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8974824918 -111.375382745
94-1033	Point to Point	S660 W1980 E4 17 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9010963678 -111.379920738
94-1034	Point to Point	N660 E1980 W4 20 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8902512521 -111.384878902
94-1035	Point to Point	S660 W660 N4 21 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8937782933 -111.366097586
94-1036	Point to Point	S660 E660 NW 21 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8938717756 -111.370724149
94-1060	Point to Point	N660 W660 S4 15 22S 5E SL	P	1879	S	0.000	0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8972309618 -111.347588997
94-1081	Point to Point	S1980 E660 N4	P	1879	S	0.000	0.000	125 SOUTH	PRICE FIELD OFFICE USA	38.8898396363 -111.324308392

		23 22S 5E SL					600 WEST	BUREAU OF LAND MANAGEMENT	
94-1082	Point to Point	S660 W660 NE 33 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8645279746 -111.357020049
94-1083	Point to Point	S660 W660 E4 35 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8567739709 -111.319678586
94-1084	Point to Point	N660 E1980 W4 25 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8750095984 -111.310575462
94-1085	Point to Point	S660 W660 NE 22 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8935110086 -111.33831118
94-1086	Point to Point	N660 E1980 W4 22 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8901022739 -111.347776982
94-1087	Point to Point	N660 W660 S4 15 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8972309618 -111.347588997
94-1088	Point to Point	S660 W660 E4 15 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9008601011 -111.33824764
94-1090	Point to Point	S1980 E660 N4 21 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8901671993 -111.361439704
94-1102	Point to Point	N660 W660 SE 12 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9115951304 -111.30082822
94-1116	Point to Point	S660 W660 N4 23 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8934522243 -111.328964374
94-1117	Point to Point	S660 W660 N4 24 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8933680942 -111.310305543
94-730	Point to Point	N660 W660 SE 21 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8828237351 -111.357261411
94-733	Point to Point	S660 W660 E4 28 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8718630517 -111.357131645
94-934	Point to Point	S660 W660 NE 01 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9372758861 -111.300451181
94-935	Point to Point	S660 W660 N4 01 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9373551837 -111.309711872
94-936	Point to Point	S660 W660 NE	P	1879	S	0.000 0.000	125 SOUTH	PRICE FIELD OFFICE USA	38.9372758861 -111.300451181

		01 22S 5E SL					600 WEST	BUREAU OF LAND MANAGEMENT	
94-937	Point to Point	N660 E1980 W4 12 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9191490874 -111.310231235
94-938	Point to Point	S660 W660 NE 14 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9081086717 -111.319568126
94-939	Point to Point	S660 W660 N4 13 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9080394651 -111.310190529
94-941	Point to Point	S660 E660 NW 01 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9374464057 -111.31433018
94-942	Point to Point	S660 E660 W4 01 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9301735169 -111.314557722
94-943	Point to Point	S660 W660 N4 11 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9228753632 -111.32878244
94-944	Point to Point	N660 W660 E4 10 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.919161214 -111.338178337
94-945	Point to Point	S660 W1980 E4 10 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9155220143 -111.3428021
94-946	Point to Point	N660 E660 SW 10 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9118653397 -111.35218934
94-947	Point to Point	N660 W660 E4 09 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9191552834 -111.356739703
94-948	Point to Point	S660 E660 N4 03 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9374353014 -111.3421733
94-949	Point to Point	S660 W660 N4 04 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9374007012 -111.36537529
94-934	Point to Point	S660 W660 NE 01 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9372758861 -111.300451181
94-1185	Point to Point	N660 W660 S4 14 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8970778454 -111.32898108
94-1186	Point to Point	N660 W660 SE 15 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8971366251 -111.338328364

94-1187	Point to Point	S660 E660 NW 24 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.893405358	-111.314978062
94-1188	Point to Point	S660 E660 N4 23 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8934652619	-111.324324859
94-1189	Point to Point	S660 W660 E4 24 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8860380609	-111.301083635
94-1218	Point to Point	N660 W660 SE 15 22S 5E SL	P	1879	S	0.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8971366251	-111.338328364
94-1289	Point to Point	N660 W660 SE 16 22S 5E SL	P	1879	S	0.000 0.000	675 EAST 500 SOUTH, 5TH FLOOR	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.	38.8973245638	-111.356849649
94-1290	Point to Point	S660 W660 E4 16 22S 5E SL	P	1879	S	0.000 0.000	675 EAST 500 SOUTH, 5TH FLOOR	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.	38.9009622773	-111.356821711
94-1291	Point to Point	N660 E660 SW 16 22S 5E SL	P	1879	S	0.000 0.000	675 EAST 500 SOUTH, 5TH FLOOR	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.	38.8974973754	-111.370742988
94-1292	Point to Point	N660 W660 S4 16 22S 5E SL	P	1879	S	0.000 0.000	675 EAST 500 SOUTH, 5TH FLOOR	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.	38.8974038956	-111.366116189
94-135	Point to Point	N2050 W1 SE 18 22S 5E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9012735634	-111.391723257
94-1178	Surface	S1050 W85 E4 24 22S 5E SL	P	1883	IS	1.750 0.000	P.O. BOX 421	SHAYNA HOUSEKEEPER	38.8849720669	-111.299058357
94-1179	Surface	S1050 W85 E4 24 22S 5E SL	P	1884	IS	5.250 0.000	P.O. BOX 421	SHAYNA HOUSEKEEPER	38.8849720669	-111.299058357
94-1183	Surface	N550 W1150 S4 15 22S 5E SL	P	1882	IS	3.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8969236657	-111.34930985
94-1184	Surface	N550 W1150 S4 15 22S 5E SL	P	1883	IS	1.000 0.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY, L.L.C.	38.8969236657	-111.34930985

94-1190	Surface	S1050 W85 E4 24 22S 5E SL	P	1883	IS	1.750 0.000	P. O. BOX 533	WILLIAM B. STANSFIELD, JR., VICKIE STANSFIELD AND SHAYNA STANSFIELD	38.8849720669	-111.299058357
94-1191	Surface	S1050 W85 E4 24 22S 5E SL	P	1884	IS	5.250 0.000	P. O. BOX 533	WILLIAM B. STANSFIELD, JR., VICKIE STANSFIELD AND SHAYNA STANSFIELD	38.8849720669	-111.299058357
94-131	Surface	N2782 W1568 NW 08 22S 5E SL	P	1879	OS	0.000 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9322381927	-111.396988853
94-132	Spring	S500 E1850 NW 07 22S 5E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9232460074	-111.398325354
94-133	Spring	S1700 E1730 NW 07 22S 5E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.9199485901	-111.398728858
94-1398	Spring	N2150 W350 SE 07 22S 5E SL	P	1879	OS	0.015 0.000	324 - 25TH STREET	USA FOREST SERVICE	38.916071395	-111.392720184
94-1901	Underground	N400 W530 S4 36 22S 5E SL	A	20130220	O	0.000 4.730	C/O ARK LAND	CANYON FUEL COMPANY, LLC	38.85243468	-111.310058927
94-1904	Underground	N400 W530 S4 36 22S 5E SL	A	20140522	O	0.000 170.000	225 NORTH 5TH STREET, SUITE 900	CANYON FUEL COMPANY LLC	38.85243468	-111.310058927
94-935	Point to Point	S660 W660 NE 12 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9226142426	-111.300632401
94-936	Point to Point	S660 W660 NE 12 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9226142426	-111.300632401
94-937	Point to Point	S660 W660 E4 12 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9152918786	-111.300722679
94-938	Point to Point	N660 E660 S4 13 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.8970060225	-111.30568154
94-939	Point to Point	N660 W660 E4 13 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9042817639	-111.30091851
94-941	Point to Point	S660 W660 N4 01 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9373551837	-111.309711872
94-942	Point to Point	N660 E660 S4	P	1879	S	0.000 0.000	125 SOUTH	PRICE FIELD OFFICE USA	38.9263893845	-111.305403595

		01 22S 5E SL					600 WEST	BUREAU OF LAND MANAGEMENT	
94-943	Point to Point	S660 W660 NE 14 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9081086717 -111.319568126
94-944	Point to Point	S660 W660 E4 15 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9008601011 -111.33824764
94-945	Point to Point	N660 W660 E4 15 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.904485713 -111.338264824
94-946	Point to Point	N660 E660 W4 15 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9046020299 -111.352199615
94-947	Point to Point	N660 E1980 W4 09 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9192439478 -111.365903338
94-948	Point to Point	S660 E1980 W4 04 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9301231955 -111.365612892
94-949	Point to Point	S660 E1980 W4 09 22S 5E SL	P	1879	S	0.000 0.000	125 SOUTH 600 WEST	PRICE FIELD OFFICE USA BUREAU OF LAND MANAGEMENT	38.9156183592 -111.365884731

APPENDIX 7-27

Greens Hollow Tract

SURFACE AND GROUND WATER TECHNICAL REPORT GREENS HOLLOW COAL LEASE TRACT

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2014

1.0 INTRODUCTION

This report describes the existing surface and ground water resources occurring in the analysis area. It also evaluates potential hydrologic issues to these resources under several alternative mining scenarios, including a no action alternative, and two action alternatives.

The analysis area for the Surface and Ground Water Technical Report includes the Greens Hollow Federal Coal Lease Tract (Greens Hollow tract) as well as adjacent coal lease tracts that may be mined in conjunction with the Greens Hollow tract. In general terms, the Greens Hollow analysis area is located west of Emery, Utah, near the east edge of the Wasatch Plateau, in the Muddy and North Fork Quitchupah Creek drainages. The exact location of the Greens Hollow tract, topography, surface water monitoring stations, drainage basins, and nearby features is shown in Figure 1. In addition, the analysis area includes a 900-foot buffer to include the area that may be affected by subsidence that could extend beyond the mined area (Figure 2). The entire analysis area includes surface lands of both the Manti-LaSal and Fishlake National Forests.

1.1 STATEMENT OF PROJECT OBJECTIVES

The U.S. Department of Interior, Bureau of Land Management (BLM) is the leasing authority on the federal coal estates within the Greens Hollow Coal Lease Tract on National Forest System land. Under the Mineral Leasing Act of 1920, as amended by the Federal Coal Leasing Amendments Act of 1975, leases can only be issued by the BLM with consent from the Forest Service with lease conditions determined necessary for protection of non-mineral resources. As federal actions subject to NEPA, both the BLM leasing decisions and the Forest Service consent decisions must be based on an environmental and socio-economic analysis and appropriate NEPA documentation.

Under the Surface Mine Control and Reclamation Act of 1977 and Utah Coal Rules, the Forest Service must consent to the mine plan prior to mine development and can impose requirements for the protection of non-coal resources. The Forest Service decisions, as federal actions, are subject to the requirements of NEPA, requiring environmental analysis and appropriate NEPA documents.

Much of this technical report is based on a previous three-year study of the Muddy Creek Tract and a 2-mile buffer surrounding the tract (Cirrus 2004a, Cirrus 2004b) as well as on-going water resource monitoring in the analysis area (DOGM 2013a). Additional data were obtained from government and private entities and a review of previous work completed on areas adjacent to the Greens Hollow tract. This technical report will form the basis for an analysis of impacts on surface and ground water in the analysis area in the Supplemental Environmental Impact Statement (SEIS) for the Greens Hollow tract on the Manti-LaSal and Fishlake National Forests.

2.0 METHODS

2.1 CONTACTS MADE

The field data for this report was compiled by Cirrus Ecological Solutions, LC (Cirrus). Additional information was obtained from the SUFCO mine as well as government agencies at the local, state, and federal level. Agencies and individual resource specialists are listed below.

United States Forest Service - Manti LaSal National Forest

- Carter Reed – Geologist Manti LaSal National Forest
- Dale Harber – Geologist, Manti LaSal National Forest
- Katherine Foster – Hydrologist, Manti LaSal National Forest
- Adam Solt – Hydrologist, Fishlake National Forest
- Karl Boyer – Geologist, Manti LaSal National Forest
- Pete Kilbourne – G.I.S. Coordinator, Manti LaSal National Forest
- William Broadbear – Forester, Manti LaSal National Forest
- John Healy – Rangeland Management Specialist, Manti LaSal National Forest
- Don Riddle – Law Enforcement Officer, Manti LaSal National Forest

United States Geological Survey

- Mike Enright – Supervisor Hydrology Technician, West Valley City Field Office
- Vic Heilweil – Hydrologist, West Valley City, District Office
- Johnny Wheat – Engineering Technician, Stennis Space Center, Mississippi

Utah Division of Oil, Gas and Mining

- Susan White – RDCC and NEPA Coordinator
- Mark Mesch – Program Administrator (retired)
- Dana Dean – Associate Director - Mining
- Dave Darby – Hydrogeologist
- Ken Wyatt – Senior Reclamation Specialist (retired)
- Jim Smith – Senior Reclamation Hydrologist

Utah Division of Water Rights

- Scott Clark, Water Rights Specialist, North Region
- Marc Stilson, Regional Engineer, Southeastern Regional Office

Utah Division of Drinking Water

- Mark Jensen, Environmental Scientist, Ground Water Source Protection and GIS Development
- Kate Johnson, Environmental Scientist, Surface Water Protection

University of Utah

- Jim Ehleringer - Professor
- Craig Cook – Laboratory Manager

Emery Water Conservancy District

- Jay Humphrey – District Manager

Muddy Creek Irrigation Company

- Morris Sorenson – Board member
- Wayne Staley – Board member

Canyon Fuel Company

- Mike Davies – Construction Engineer, SUFCO mine
- Chris Hansen – Environmental monitoring, Skyline mine

Petersen Hydrologic

- Erik Petersen – Senior Hydrogeologist

ChemTech Ford Laboratory (EPA-certified)

- David Gayer – Laboratory Manager

CT&E Laboratory (EPA-certified)

- Brandon Pierce – Laboratory Manager

GeoChron Laboratory (EPA-certified)

- Dick Ressman – Laboratory Manager, Stable Isotope
- Alex Cherkinski - Laboratory Manager, Age Dating

Sequoia Scientific

- Lydia Sundman – Electronic Engineer, AquaRod Division

Additional information was obtained from data repositories maintained by the Manti-LaSal National Forest, U.S. Geological Survey (USGS), U.S. Environmental Protection Agency (EPA), Utah Division of Water Quality, (Utah DWQ), Utah Division of Drinking Water (Utah DDW), Utah Division of Water Rights (Utah DWRi), Utah Department of Water Resources (Utah DWRe), Utah Automated Geographic Reference Center (AGRC), and the Utah Division of Oil, Gas, and Mining (DOGM).

2.2 SOURCES AND DESCRIPTIONS OF EXISTING INFORMATION

This baseline evaluation included a review of reports and data from Utah and Federal agencies concerning water resources of the region. Canyon Fuel's SUFCO Mine, has extracted coal from the lease tract areas adjacent to the Greens Hollow tract including parts of the Pines Tract and the Quitchupah Tract lease (Figure 1). Consequently, existing information has also been obtained from the Permit Application Package (PAP) and the Hydrologic Monitoring Reports for the SUFCO Mine, USGS investigations (Thiros and Cordy 1991), the Probable Hydrologic Consequences for the SUFCO Mine (Mayo and Associates 1999) the hydrologic information developed for the Final EIS of the Pines Tract (USDA-FS 1999), the Cumulative Hydrologic Impact Assessment prepared by DOGM (2003a) for the SUFCO Mine, water quality monitoring assessments completed in the Muddy Creek drainage (Utah DWQ 2004), the Muddy Creek Water Resources technical report (Cirrus 2004a), ongoing monitoring data collected by SUFCO (DOGM 2013a) field geology surveys (Anderson 2008a), and evaluations of exploratory drill-hole log information (Anderson 2008b).

Thiros and Cordy (1991) described the hydrology and potential effects of mining in the Quitchupah and Pines Coal Lease Tracts. The geologic formations and ground water bearing units in the Muddy Creek Tract are essentially the same as in the adjacent Quitchupah and Pines Coal Lease Tracts, although the North Horn Formation occurs over a large portion of the Muddy Creek Tract and the Flagstaff Limestone is found at the tops of ridges and mountains on the far west side of the analysis area. A generalized stratigraphy of the Muddy Creek Tract is depicted in Figure 3.

A gain loss study of flows in North Fork Quitchupah Creek found an apparent gain in flow where the creek crossed the Castlegate Sandstone, a loss of flow as it crossed the upper part of the Blackhawk Formation, a slight gain in flow crossing the lower Blackhawk formation, a considerable gain in flow crossing Star Point Sandstone, and a loss in flow crossing the Mancos Shale (Thiros and Cordy 1991).

Mayo and Associates (1999) used carbon-14 (C^{14}) radiocarbon dating and tritium (^3H) analysis of spring water and ground water in the Pines Tract and surrounding area, including mine water in the SUFCO Mine, to conclude that the ground-water encountered in the mine was distinct from the near-surface ground-water systems associated with the springs. Most of the near-surface systems contain abundant ^3H and anthropogenic (human-caused) radiocarbon while the waters in the mine have a mean residence time of 7,000 to 20,000 years and contain no ^3H. The cause of this disconnect is attributed to shale and mudstone in the Blackhawk Formation that hinder the downward migration of water. This conclusion was consistent with the unsaturated horizons encountered in exploration drill-holes at the SUFCO Mine.

The Final EIS for the Pines Tract (USDA-FS 1999) described the surface and ground water systems and projected mining-related hydrologic impacts in the adjacent Pines Tract Lease. Water in the springs that were apparently discharging from the Castlegate Sandstone was relatively low in TDS and undersaturated with respect to carbonate minerals. The waters from Price River Formation springs exhibited considerably higher TDS and were oversaturated with respect to carbonate minerals. These results showed that the water in the Castlegate Sandstone springs had not been in contact with the Price River Formation and that the source water for the springs was direct recharge of the Castlegate Sandstone outcrop in the plateau areas along the perimeter of the canyon rims. The springs and seeps issuing from the base of the Castlegate Sandstone are apparently the result of perching caused by shales and siltstones in the upper portion of the Blackhawk Formation (DOGM 2003a). The Star Point Sandstone underlies the coal bearing portion of the lower Blackhawk Formation. The base of the Star Point Sandstone consists of thin interbedded sandstones, siltstones and shales. The upper portion of the Star Point Sandstone consists of three massive sandstone layers (Thiros and Cordy 1991). Underlying the Star Point Sandstone is the Masuk Member of the Mancos Shale (also known as the Blue Gate

Shale Member of the Mancos Shale). The Mancos Shale is a regional aquaclude that limits downward flow and acts as a lower boundary for the regional ground water system.

A Total Maximum Daily Load (TMDL) study was completed on Muddy Creek and tributaries in January 2004 as part of a water quality study completed by the Utah DWQ that examined concentrations of Total Dissolved Solids (TDS) on the West Colorado Management Unit (Utah DWQ 2004). The study indicated that several water bodies in the Muddy Creek drainage were not supporting their assigned Class 4A agricultural beneficial use due to TDS concentrations that exceeded the recommended criterion of 1,200 mg/l. These water bodies include the following:

- Muddy Creek and its tributaries from Ivie Creek confluence to the Utah Highway 10 bridge.
- Quitchupah Creek from the confluence with Ivie Creek to the Utah Highway 10 bridge.
- Ivie Creek and its tributaries from the confluence with Muddy Creek to Utah Highway 10.
- Muddy Creek from the confluence with the Fremont River to Quitchupah Creek confluence.

Historic monitoring of these water bodies indicates that TDS concentrations in the upper areas of the Muddy Creek watershed are below the 1,200 mg/l criterion and are considered to be in full support of beneficial uses. Much of the upper Muddy Creek watershed is comprised of lands administered by the MLNF. The average TDS concentration reported in the TMDL for Quitchupah Creek above the MLNF boundary was 675 mg/L, based on 10 samples (Utah DWQ 2004) collected during 1997-98. SUFCO monitoring data near this location has a mean of 663 during the same time period (based on 6 available samples) and a 20-year mean of 682 mg/l TDS during 1993-2012 (based on 53 samples) (DOGM 2013a). The mid-to-lower portions of the watershed are a mixture of urban and agricultural land uses. Measured TDS concentrations in these areas consistently exceed the 1,200 mg/l criterion. Some of the known sources of TDS in the Muddy Creek watershed include land areas where the Mancos Shale and Blackhawk formations are exposed to erosion processes and are in contact with surface water bodies. Other sources were noted to include agricultural and urban land use and some coal mining. Instream TDS concentrations were observed to be highest during periods of low flow when ground water and irrigation return flows with elevated TDS concentrations provide the main source of water to streams and canals.

Pollutant loads were calculated for point and non-point sources of pollution in the Muddy Creek watershed. Point source pollution was determined to contribute 3,595 tons/year or roughly 7 percent of existing loads while non-point sources contributed 50,767 tons/year or approximately 93 percent of TDS loads in the watershed. Discharge from the SUFCO mine outfall was determined to contribute 2,500 tons/year or approximately 70 percent of point source loading. In order to meet the TDS criterion of 1,200 mg/l in the Muddy Creek watershed, pollutant loads from non-point sources would need to be reduced by 86 percent. No reductions from point source loads were recommended. As a result of the TMDL, site specific standards are currently in place for the impaired segments listed above. However, the TDS standard for Muddy Creek upstream of Utah Highway 10 and Quitchupah Creek above the MLNF boundary remains at 1,200 mg/l.

The Muddy Creek Water Resources technical report (Cirrus 2004a) summarizes the 2001-2004 data collection effort completed to assess subsidence impacts on water resources in the Muddy Creek and Quitchupah Creek drainages. Measurements of flow and water quality were collected from all springs and selected stream segments in the analysis area during the spring and fall season. Additional measurements were collected on a quarterly basis from selected spring and stream monitoring sites. The number and type of measurements were defined by the MLNF and the Utah Division of Oil Gas and Mining (DOGM). All data collected as a result of this effort was uploaded to the DOGM online monitoring database. The technical report identified subsidence impacts on water resources under two mining scenarios. A detailed record of all data used in the technical report is compiled in Appendix 1 to the Muddy Creek Water Resources technical report (Cirrus 2004b).

SUFCO has been required to monitor stream and spring monitoring sites in and adjacent to the Greens Hollow tract as part of the DOGM permitting process (DOGM2013a). SUFCO monitoring sites applicable to this project include three stream and six spring locations. Monitoring of two sites on Quitchupah Creek began in 1982. Stream monitoring at one location on Greens Hollow and six spring sites commenced in 2006 when the SITLA Coal Lease Tract was added. SUFCO is continuing to monitor each of the three stream and six spring sites. All monitoring data collected from these sites was reviewed as part of this assessment.

Geologic contact lines in the analysis area were assessed during field surveys completed in 2008 to determine the nature of the Castlegate Sandstone/Price River contact and to estimate physical properties of material directly overlaying this formation (Anderson 2008a). Field observations indicated that stream channel segments in Greens Hollow and Cowboy Creek located on Castlegate Sandstone were primarily comprised of consolidated fine-textured material and estimated to contain 90% clay. Channel segments of North Fork Quitchupah Creek that occurred on Castlegate Sandstone were comprised of unconsolidated deposits that varied from clay-rich, well stratified material to young alluvium containing a matrix of clay with sand, and pebble-boulder sized clasts (mostly limestone with minor sandstone). Additional geologic information was obtained through an evaluation of exploratory drill-hole data (Anderson 2008b). This assessment defined the structural position of the top of the Castlegate Sandstone as well as the lithologic content of the stratigraphic interval 50 feet directly above this formation. Data records were provided by the SUFCO mine for approximately 20 exploratory drill-hole logs in the analysis area including both geophysical and sample recordings. Results of the study produced structural elevation contours at 20 foot intervals and also indicated that rock in the 50 foot interval above Castlegate Sandstone contained an average of 74 percent silt/mudstone and 26 percent sandstone.

2.4 DESCRIPTION OF INVENTORIES AND DATA COLLECTED BY THE CONSULTANT

Surface and ground water resources in the Greens Hollow tract area were monitored by Cirrus during 2001-2004. All flow and water quality measurements collected during this time adhered to USGS and EPA standards including collection procedures, sample hold times, laboratory certification, and cleaning and maintenance of field equipment. All water quality sampling procedures were guided by information obtained from the National Field Manual for the Collection of Water Quality Data (USGS 2003), recommendations from USGS scientists in Salt Lake City and water chemistry specialists employed at EPA-certified laboratories. All laboratory samples were stored on ice immediately after they were collected and delivered to an EPA certified laboratory located in Huntington, Utah or Salt Lake City, Utah within the allotted holding period associated with the parameters being tested. All water quality samples tested for dissolved metals were vacuum-filtered in the field through a 0.45 μm cellulose-nitrate filter. The measurement devices used during field measurements of flow and water quality included the following instruments:

Discharge measurements

- Price AA current meter
- Pygmy current meter
- Baski eight inch cutthroat flume
- Modified Parshall flume with three inch throat (Rantz 1982)
- PVC pipe (three inch diameter) and bucket

Water quality measurements

- YSI63 (temperature, pH, conductivity, salinity)
- YSI55 (temperature, dissolved oxygen in mg/l and percent saturation)
- LaMotte turbidimeter (turbidity in ntu)
- Global Water WQ770 turbidimeter (turbidity in ntu)

Calibration of these sensors to traceable standards occurred at recommended intervals throughout the monitoring period. Calibration data during 2001-2004 is included in the project record accompanying the Muddy Creek Water Resources technical report. A description is provided below of the work completed to collect water resource data in the analysis area.

2.4.1 Ground Water Aquifers

Field information on the location and extent of ground water discharge points (springs) in the Greens Hollow tract was collected during the early 2001 spring season as part of the spring and seep survey associated with the Muddy Creek Tract area. The initial spring coverage was added to in subsequent years as more information was obtained identifying new points of ground water discharge. The majority of spring monitoring was limited to 2001-2004. SUFCO has continued to monitor a select number of springs and stream locations in the Greens Hollow tract since that time. The geologic formation associated with each spring was determined from a geologic map completed by Anderson (2004). This map also contains structural geologic profiles for the Tract area, fence diagrams based on information obtained from exploratory drilling, and mapped alluvial deposits (Anderson 2004). Some information defining the piezometric surface in the analysis area was obtained from exploratory wells completed by private mining companies. Additional information defining the timing of recharge to aquifers was obtained from stable isotope measurements collected at points of ground water discharge (springs). A detailed discussion of aquifer properties associated with the geologic layers that underlay the analysis area is included in Section 3.1.1 Ground water Aquifers and Springs.

2.4.2 Wells

The effort to identify wells in the analysis area included a search of government databases including the DOGM well information database, Utah DWRi water rights database (including the well information program and water rights database), and the USGS NWIS online database. This search failed to identify well monitoring sites, including water production wells in the analysis area. A review of monitoring data collected from wells adjacent to the analysis area indicated that measurements were limited to water level. Water quality parameters were not measured due to the fact that material surrounding the well borehole had not been developed (similar to a culinary well) and were contaminated from drilling fluids.

2.4.3 Springs and Seeps

A survey of existing water features was conducted in the analysis area to identify springs and seeps with measurable flow. The initial field survey of springs in the Greens Hollow tract was completed in the summer of 2001 as part of the work effort associated with the Muddy Creek Tract assessment. Prior to conducting the survey, the Muddy Creek Tract was subdivided into priority areas on the basis for the potential for subsidence from mining activities to impact a spring or surface water body (Figure 2). These areas were used to guide field efforts, resulting in areas of higher priority being inventoried before lower priority areas. However all areas have been inventoried for the presence of springs and seeps with measurable flow.

The areas of highest priority (Priority 1) included all locations in the Muddy Creek Tract with low overburden cover as shown in Figure 2. Priority 2 areas included all locations in the Tract where the overburden cover was at least 400 feet, which is sufficient to reduce substantial impacts of subsidence. Priority 3 areas are located stratigraphically above Priority 2 areas and encompass the remainder of the analysis area. A single spring with measurable flow (M_SP87) was located in the Priority 1 area. All springs with measurable flow located inside the Tract boundary in the

Priority 2 area were selected for baseline monitoring. Discharge rates and location were used to prioritize the springs retained for monitoring in the Priority 3 buffer area.

Additional information on springs and seeps was obtained from range allotment files for the Emery and Ferron allotments, and recommendations provided by grazing permitees. All springs found during the initial field effort were checked against this information and springs that had not been previously identified were located and assessed for measurable flow.

All spring locations were defined with a Trimble GeoExplorer3 GPS unit accurate to +/- 2 meters in the horizontal plane. A digital photo was taken of the spring or seep for descriptive purposes. A report including a date-stamped digital photo, probable source and apparent use of each spring is included in Cirrus (2004b). Field measurements were also taken at each location including flow (gpm), water temperature (°C), pH, conductivity (umhos/cm), and salinity (ppt). Flow measurements were collected from springs using a pipe and bucket, and were typically measured three times from each spring in order to get an average flow value.

Information from the initial field effort was submitted to the MLNF during the summer of 2001 for review and selection of springs for intensive water quality measurements during the spring and fall seasons, including eight springs that were located in the Greens Hollow tract. Additional water samples collected during fall 2001 (base flow) from the eight spring monitoring sites were measured for ^{3}H, deuterium (^{2}H), oxygen-18 (^{18}O), and carbon-14 (C^{14}). In July of 2002, DOGM requested that additional parameters be measured on a quarterly basis at spring monitoring sites previously selected by the MLNF for laboratory testing. Quarterly monitoring of the eight springs continued from that time through 2004. All springs with measurable flow in the Muddy Creek Tract analysis area were monitored for flow and field water quality parameters during the spring and fall seasons from fall 2001 through spring 2004. SUFCO has continued to collect field measurements since that time from five of the eight springs selected for intensive measurement. The geographic locations of all springs in and immediately adjacent to the Greens Hollow tract that support measurable flow are included in Figure 4. A definition and discussion of spring value is presented below in Section 3.1.1.8 Ground Water Summary. The results of all flow and water quality measurements collected from springs identified in the analysis area, including the SUFCO monitoring data, can be found in Cirrus (2004b).

Several springs were instrumented for measurement of continuous flow including one spring (M_SP02) that is located in the Greens Hollow tract boundary. These springs were selected following discussions with MLNF personnel and individuals from the Emery Water Conservancy District (EWCD). Following approval by the MLNF, members of the EWCD installed two inch inline vortex flowmeters capable of measuring continuous flow (gpm) at the selected spring sites during the summer of 2002. Flow sensors were accessed using remote telemetry and provided 30-minute averages of flow readings collected at five-minute intervals from each spring. Some difficulty was encountered in maintaining a continuous flow record for each spring as sensors would be periodically disturbed by cattlemen, livestock and wildlife using the area for grazing and watering purposes. Maintenance of spring flow monitoring locations was discontinued after 2004 due to vandalism of monitoring equipment.

Probable source area for each spring or group of springs was determined from a combination of measured field data, laboratory analysis of water quality samples, and available mapping information. Potential inputs included geology, topography, field observations, spring flow rates, water quality parameters, and isotopic analysis. Nearby springs were grouped together when their probable source areas overlapped substantially. Many of the springs appear to be topographically controlled with fairly localized source areas. Based on the spring flow rates and water quality parameters, an estimate was made of how far the probable source area extended upgradient above the point of discharge.

2.4.4 STREAMS

A total of 10 stream monitoring sites were established in and adjacent to the Greens Hollow tract. The main stem of Muddy Creek was not considered for collection of field data under this project. SUFCO established stream monitoring sites in 1982 at two locations on North Fork Quitchupah Creek. Monitoring has continued at these locations on a quarterly basis since that time. The initial effort to identify stream monitoring locations in the Greens Hollow, Cowboy Creek, and Greens Canyon area was based upon GIS stream coverage obtained from the MLNF. A total of six sites were selected for monitoring including four sites with continuous flow sensors and two non-instrumented sites. An effort was made to select monitor locations that appeared to support perennial flow and were free of debris jams or bank sloughing. Other factors that were considered included channel features such as near-vertical, confining channel banks and linear channel segments with high amounts of riffles and few meanders or pools. Flow sensors were installed in June 2002 following a field visit with MLNF personnel. Monitoring of the two non-instrumented sites began at this time as well. In July of 2002, DOGM requested that two additional stream channel locations be instrumented for continuous flow. These sites were established in August 2002. The geographic locations of all 10 stream monitoring sites considered in this report are included in Figure 1.

Continuous flow measurements were collected with AquaRod water depth sensors that measured water level in a stilling well located adjacent to the stream channel. Data were downloaded from each sensor at approximately 6 week intervals throughout the season. At the end of the field season, all data were removed from the datalogger in each sensor, providing approximately 6 months of data storage for water measurements collected during the winter months. New lithium batteries were also installed in each sensor at the end of the field season.

The relationship between water level (stage) measured by AquaRod sensors and stream discharge is defined with a stage discharge curve. This curve was defined with manual readings of stream discharge collected during a range of flows. The method used to measure stream discharge was dependent upon the flow rate occurring in the stream channel during the field visit. An effort was made to obtain high-flow readings during the early spring season in order to provide a more accurate stage-discharge curve. Due to the restricted access produced by snow depth, snowmelt, and high soil moisture levels in Greens Canyon, the lower portion of Cowboy Creek, and the mine tract area in general, streamflow measurements could not be made until the latter part of April through mid-May. As a result, the number of high flow readings is limited for some sites. Stream monitoring sites instrumented with AquaRod sensors were visually monitored for significant changes throughout the extent of the monitoring period to identify any changes in channel shape that would influence the stage-discharge relationship. No changes of this nature were observed at any stream monitoring site during the life of the project. A complete listing of all data used to develop stage-discharge curves is included in Cirrus (2004b).

Water quality measurements were collected from (2002-2004) at the six instrumented stream monitoring sites four times during the year including early spring as soon as the site was accessible, late spring/early summer, mid-summer, and fall. The two non-instrumented stream sites and the two stream locations maintained by SUFCO were monitored on a quarterly basis. As a result, measurements at these sites were typically collected only three times per year as adverse conditions prohibited access during the winter quarter. A complete listing of all water quality data collected at stream monitoring sites during the Muddy Creek Tract survey (2001-

2004) is included in Cirrus (2004b). SUFCO has continued to visit one of the original six instrumented monitoring sites on a quarterly basis as well as the two other stream locations they maintain (DOGM 2013a).

A longitudinal profile survey was completed on all of Greens Canyon, and portions of Cowboy Creek, and Greens Hollow that were either perennial in nature or maintained perennially functioning riparian vegetation. Stream channel elevation and distance measurements were obtained with a TOPCON total station and recorded with a Trimble datalogger. Survey points were typically measured in the channel thalweg and usually separated by distances no greater than 150 feet. Occasionally this distance was exceeded due to vegetation or topography interfering with the line of sight needed to complete a measurement. Additional efforts were made to survey channel elevation at the top and bottom of extreme changes in channel gradient such as waterfalls or large debris jams. Following the survey, all measurements were downloaded to a CAD viewing program and the false X, Y and Z coordinates associated with the original survey were transferred to actual UTM NAD 1927 coordinates. Differences in horizontal and vertical coordinates were used to determine channel slope. All data associated with the longitudinal profile survey is included in Cirrus (2004b).

A gain-loss study was conducted on perennial stream segments of Greens Hollow, Cowboy Creek, and Greens Canyon during baseline (fall) conditions. During the gain-loss survey, flow and water quality measurements were taken at the mainstem of Greens Hollow and a flowing tributary to the stream, located near the headwater area. Flow in this tributary was supported by discharge from M_SP04, M_SP05, and M_SP06 and was the only flowing tributary present during base flow conditions. Flow below this point continued in the main stem of Greens Hollow to a point approximately 0.5 miles above the confluence with Cowboy Creek. No flowing tributaries were identified along Cowboy Creek or in Greens Canyon. Additional flow measurements were collected at the established stream monitoring sites including M_STR6, M_STR4, and M_STR3. All measurements were taken within a 24-hour time period. Streamflow was measured by routing all flow through a three inch PVC pipe and measuring the flow rate with a bucket and stopwatch. Water quality samples were collected on the main stem and flowing tributary approximately 25 feet above the point of confluence. A second gain-loss study was scheduled for these same stream reaches during 2002. However, continued drought conditions during 2002 produced streamflows that were significantly less than those observed during 2001. In order to obtain a greater range of measured flows, the study was rescheduled for 2003. Drought conditions continued throughout much of 2003 resulting in no flowing tributaries to the mainstream channels measured during 2001. As a result, a gain-loss survey during 2003 was not possible.

All streams maintaining perennial flow in the analysis area were mapped during baseline (fall season) conditions in 2001 through 2003. Locations where flow started and stopped were measured using GPS technology or marked on 1:24,000 scale USGS quad maps. Due to continued drought conditions during the project, the extent of perennial flow observed during fall of 2001 was greater than during any following year. As a result, this coverage was used for the assessment of impacts on perennial streams. Although no substantial changes were observed in the extent of perennial flow between 2001 through 2003, several stream channels that were noted to be continuously flowing in fall 2001 became intermittent in fall 2002 and fall 2003 with some segments drying up completely. The extent of perennial flow during fall 2001 is shown in Figure 4.

A review of historic precipitation and stream flow data provides some perspective with regards to climate patterns that occur in the analysis area. Annual precipitation totals recorded at several nearby Snowpack Telemetry (SNOTEL) stations including Buck Flat and Seely Creek, indicate that water year 2002 was well below the historic (1980-2013) total (USDA-NRCS 2013) and water years 2001 and 2003 were only slightly below average. Average annual flows during 2001-2004 for Muddy Creek near Emery, Ut were all below the historic (1952-2012) annual average flow of 37.5 cfs (USGS 2013). Annual average streamflow during the 2001 water year was 33.2 cfs or approximately 11 percent lower than the historic average.

2.4.5 Floodplains and Alluvial Valleys

The presence of floodplains and alluvial valleys adjacent to proposed surface facilities located in the analysis area were identified from a combination of field reconnaissance and review of existing mapping information. Maps prepared by the Office of Surface Mining and Reclamation were reviewed in order to determine the presence of alluvial valley floors in the analysis area. Additional information was obtained from DOGM pertaining to the amount and volume of water contained by unconsolidated alluvial deposits located in the analysis area drainages, including Muddy Creek and North Fork Quitchupah Creek.

2.4.6 Reservoirs and Ponds

The effort to identify reservoirs and ponds in the analysis area included a review of USGS 7.5 minute topographical maps, aerial photographs, range allotment information, MLNF GIS coverages, and consultation with MLNF rangeland resource specialists. No reservoirs were identified in the analysis area. Ponds were subsequently field-verified during 2001–2003.

In July of 2002, DOGM requested a field inventory of all ponds in and adjacent to the analysis area. During the field reconnaissance effort, the location of both natural ponds and stock ponds (i.e. constructed ponds) were measured using a Trimble GeoExplorer3 GPS unit that is accurate to +/- 2 meters in the horizontal plane. Several physical parameters were also measured or estimated for each pond including surface area, presence of water, source of water, and maximum depth capacity. Field reconnaissance information was compiled into a report and submitted to DOGM for review. A subset of ponds were then selected for quarterly monitoring of water depth including three stock ponds in or immediately adjacent to the Greens Hollow tract. Maximum water depth was first determined by measuring the vertical distance from a benchmark placed near the discharge channel of each pond, to the lowest point in the impoundment. In order to do this, a horizontal plane was established by stretching a leveled string from the benchmark to a location directly above the lowest point in the pond, and measuring the vertical difference. Subsequent measurements were made on a quarterly basis by completing the same process. Additional information on the location of ponds outside of the Tract boundary was obtained from MLNF range allotment files for the Ferron and Emery grazing allotments. All data collected from ponds is provided in Cirrus (2004b).

2.4.7 Water Rights

Water rights associated with springs and streams in the analysis area were identified using water rights files, hydrographic survey maps, and GIS information obtained from Utah DWRi. Discussion with Utah DWRi specialists indicated that GIS locations of water rights were typically estimated and would likely not correspond precisely with GPS locations of water features. Additional information was obtained from hydrographic survey maps regarding the geographic locations of water rights. A comprehensive assessment of all water rights in the analysis area was completed using GPS locations of springs, hydrographic survey maps, and GIS information to determine potential water rights associated with identified water features. A complete listing of all water rights and their associated water features identified during the Muddy Creek Tract field survey is contained in Cirrus (2004b). A more recent review of all water rights in the mining analysis area boundary identified additional perfected or approved water rights acquired on springs and streams during the past 10 years. These additional water rights included 28 held by the U.S. Forest Service and 1 additional water right held by Canyon Fuel Company (Cirrus 2014). Additional discussion of existing water rights in the mining analysis area is included below in Section 3.1.3.

2.4.8 Drinking Water Source Areas

Map coverage of drinking water source areas, including protection zones for surface and ground water sources, as well as points of diversion were obtained from the Utah DDW. Although many of these areas were located at nearby locations outside of the analysis area, it was determined these should be addressed due to the potential for indirect impacts to occur. Additional information on drinking water source areas was obtained through discussions with surface and ground water resource specialists at the Utah DDW. A complete listing of all drinking water source areas and their respective protection zones is contained in Cirrus (2004b). More recent discussions with the Utah DDW have confirmed these source areas and protection zones have not changed since the Muddy Creek Tract survey was finished (Jensen 2013).

3.0 RESULTS AND DISCUSSION

This section of the technical report describes surface and ground water resources in the analysis area (Section 3.1) and then determines potential effects of the conceptual mine operation on these resources (Section 3.2). The source of data used to describe existing water resources was described in detail in Sections 2.2, 2.3, and 2.4. A description of the alternatives that define conceptual mine operations is included in Section 1.3.

3.1 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The Greens Hollow tract comprises an area of about 10 square miles located in the southern Wasatch Coal Field, approximately 60 miles southwest of Price, Utah, and about 6 miles northwest of Emery, Utah. The analysis area is 17.2 square miles including the Greens Hollow tract and a 900 foot buffer zone surrounding the tract (Figure 2). Elevations within the analysis area range from approximately 7,400 feet near Muddy Creek on the east to about 9,700 feet on the east flank of White Mountain, located on the west side of the analysis area. The two primary streams draining this area are Muddy Creek and North Fork Quitchupah Creek. The Muddy Creek watershed above USGS Station 09330500, Muddy Creek near Emery, Utah, is approximately 108 square miles. The North Fork Quitchupah Creek watershed above the SUFCO Mine monitoring station 042 is approximately 24 square miles. Approximately 10.8 square miles (63 percent) of the analysis area is contained in the Muddy Creek drainage and 6.4 square miles (37 percent) are found in the North Fork Quitchupah Creek drainage.

Water resources in the analysis area include springs, streams, and ponds that are primarily used for wildlife and stock watering purposes. There are no registered water supply wells in the analysis area and ground water is only used at the point of surface discharge at springs and seeps.

Water yield from upper watersheds, including the analysis area, provides most of the domestic and agricultural water needs for the lower valley.

3.1.1 GROUND WATER AQUIFERS AND SPRINGS

The ground water baseline assessment provides a description of pre-mine conditions for each water-bearing stratum, including the coal seam, and any potentially impacted strata above and below the coal seam. Lithology and structure of the analysis area have been described by Anderson (2004) and include the Blackhawk, Price River, Castlegate, and North Horn geologic formations as well as landslide deposits overlaying the North Horn formation. Figure 4 provides the locations of springs with measurable flow and geologic formations within or in reasonable proximity to the Greens Hollow tract. As mentioned previously, Figure 3 depicts the lithology in the analysis area.

The Masuk Member of the Mancos Shale (also known as the Blue Gate Shale Member of the Mancos Shale) outcrops along the eastern edge of the Wasatch Plateau, including along the lower portion of Muddy Creek to the east of the analysis area. The Masuk Member of Mancos Shale consists of blue-gray shale or silty claystone that weathers light blue-gray to light tan. The unit does not feature springs or comprise an aquifer.

The Mesaverde Group overlies the Mancos Shale and consists of the Star Point Sandstone, Blackhawk Formation, Castlegate Sandstone, and Price River Formation which all contain ground water and are capable of transmitting ground water flow.

The Star Point Sandstone consists of three massive sandstone layers, the uppermost of which intertongues with the Blackhawk Formation (Thiros and Cordy 1991). The Star Point Sandstone is the lowest aquifer unit that could be affected by proposed mining. The target coal seam (Lower Hiawatha) is located near the base of the Blackhawk Formation. The Blackhawk Formation is comprised of interbedded coals, sandstones, shale and mudstone. Sandstone decreases towards the base of the Blackhawk while the coals are present in the lower part of the Blackhawk. The finer-grained rocks in the Blackhawk can contain abundant swelling clays (Mayo and Associates 1997a). Vertical flow is restricted but may occur as unsaturated flow along fractures through perching beds (Lines 1985). The target coal and the Star Point Sandstone are likely to be saturated everywhere in the Greens Hollow tract but may be unsaturated beyond the Tract near outcrops at the edge of the plateau and in canyons (Thiros and Cordy 1991). Thiros and Cordy (1991) also note that artesian pressures ranging from 129 to 315 feet were measured in four observation wells completed in the upper Hiawatha coal seam by SUFCO in the vicinity of Duncan Mountain. Three other monitoring wells completed in the upper Hiawatha coal near the edge of the Wasatch Plateau were found to be dry. Most of the ground water in the Blackhawk formation is found in sandstone paleochannels or as localized perched zones above the saturated portion of the Blackhawk Formation. Vertical or horizontal hydraulic communication between sandstone channels is prevented by the shale and mudstone layers that surround sandstone paleochannels

Thiros and Cordy (1991) observed that ground water flow in the Castlegate Sandstone occurs as perched water flowing laterally along bedding planes in the direction of dip. Ground water flow in the Castlegate Sandstone is limited, as indicated by the occurrence of only one spring discharging from this formation in the Greens Hollow tract. The Castlegate Sandstone is overlain by the Price River Formation. The Price River Formation consists of medium- to coarse-grained sandstone, interbedded shale, and some thin beds of conglomerate. Mudstone drapes deposited during low-flow periods separate fluvial sandstones from each other both horizontally and vertically (USDA-FS 1999). Siltstones and shales in the Price River Formation were found to include 15 percent smectite (swelling) clays (DOGM 1992). It appears that much of the ground water recharge for the Price River Formation flows laterally where it discharges as springs and seeps. Some ground water flows vertically into the Castlegate Sandstone, where it is perched above the Blackhawk Formation, although only one Castlegate spring occurs in the Tract. Vertical flow from the Castlegate Sandstone into the Blackhawk Formation is restricted by shales and clays although some vertical movement still occurs as unsaturated flow along fractures in the Blackhawk.

The North Horn Formation overlies the Mesaverde Group and is the uppermost consolidated formation in the Greens Hollow tract. The North Horn Formation occurs over a large portion of the Tract. Flagstaff Limestone is found at the tops of ridges and mountains west of the analysis area. The North Horn Formation is considered to be the uppermost unit that could be affected by proposed mining because the Flagstaff Limestone outcrop is more than one-half mile to the west of the Tract. Unconsolidated deposits formed by weathering and erosion occur as colluvium, alluvium and soils. Slumping and landslides associated with clay-rich units in the Price River and North Horn Formations also occur further back from the escarpments and can be identified by the hummocky topography. The slumps and landslides vary in size from a few acres to hundreds of acres (Anderson 2004). Based on the geologic characteristics of the North Horn and the large number of springs and seeps, it appears that most ground water in the North Horn Formation moves laterally and ultimately discharges in the form of springs and seeps. Vertical flow into the Price River Formation is restricted by shales and clays in the North Horn Formation. Danielson and Sylla (1983) found that 90 percent of springs and seeps that were inventoried in coal-resource areas in the southern Wasatch Plateau, discharged from the North Horn Formation. The data from this study were not sufficient to determine if ground water in the North Horn Formation is perched or part of a continuous saturated zone. In either event, it is clear that shales and clays in the North Horn Formation restrict vertical flow of ground water.

During the spring and fall of 2001-2004 Cirrus monitored all springs with measurable flow located in the Greens Hollow tract and adjacent areas. A detailed description of monitoring efforts is provided in Section 2.4. Location information for each spring along with measurements of flow and specific conductance are summarized in Table 1. Electronic data files with field measurements and water quality analysis results are provided in DOGM (2013a). Figure 5 and Figure 6 show the range of measurements for flow and specific conductance, respectively, for springs associated with each geologic formation, based on all measurements collected at these sites from 2001 to 2012. Eight springs were also monitored in the analysis area on a seasonal basis (i.e. four times per year) for baseline flow and water quality. The rationale for selection of these springs is described in Section 2.3. No monitoring wells were installed for the baseline program, although several monitoring wells have previously been installed on nearby coal leases. Water level data from these wells were used where applicable, to support the discussion of ground water resources.

The Utah DWQ is responsible for monitoring water quality of all waters of the State and works cooperatively with other agencies to achieve this task. Water quality samples collected from the eight monitored springs were assessed for compliance with applicable numeric criteria and pollution indicator values used by the Utah DWQ. Numeric criteria and pollution indicator values have been assigned to all water bodies in Utah (including streams, rivers, lakes, and reservoirs) with the objective of protecting the highest beneficial use of the water resource. Beneficial use categories associated with the analysis area include Class 1C (Drinking Water), Class 2B (Secondary Contact Recreation), Class 3A (Cold Water Aquatic Life), Class 3C (Non game Fish), and Class 4 (Agriculture).

Water quality of springs and streams is considered dynamic and can exhibit seasonal and interannual variations. These patterns can be observed at disturbed sites as well as at locations that are considered pristine and without anthropogenic influence. Naturally high concentrations of some water quality constituents can also occur as water comes in contact with parent materials found in Utah and surrounding areas that have high ambient concentrations of certain constituents such as saline Mancos Shale. A threshold is used by the Utah DWQ to account for normal levels of variation when water quality samples are evaluated. If less than 10 percent of samples violate standards or pollution indicator values, water quality is considered to fully support the assigned beneficial use. If more than 10 percent of samples are in violation, the water body is considered impaired and further investigation is warranted. The number of samples and length of monitoring required for an evaluation varies according to the water quality parameter in question.

Samples collected in the fall of 2001 from eight springs were also analyzed for stable and unstable isotopes. The unstable isotopes ^{14}C and ^{3}H were measured to provide estimates of the approximate age or residence time of water issuing from springs, while the stable isotope ratios of oxygen ($^{18}O/^{16}O$ reported as $\delta^{18}O$) and hydrogen ($^{2}H/H$ reported as δD) were measured to help characterize likely recharge sources and mechanisms for springs and the underlying aquifers. The stable isotope ratio of dissolved inorganic carbon ($^{13}C/^{12}C$ reported as $\delta^{13}C$) is typically collected to help in the age adjustment of the carbon-14 results. The isotope analysis results for the analysis area springs are included in Figure 7 and are discussed below.

Tritium is a naturally occurring radioactive isotope of hydrogen that has a half-life of 12.43 years. Tritium levels in rainfall dramatically increased above natural background levels starting in about 1954 as a result of nuclear testing. Tritium is measured in ^{3}H units (TU) and, if detectable, provides a qualitative indicator that the ground water has a component of water that recharged since about 1954. Because ^{3}H is part of the water molecule, ^{3}H is not affected by reactions other than radioactive decay; therefore, ^{3}H is an excellent tracer of recent ground water recharge. Ground water that recharged prior to 1954 will contain little to no ^{3}H. Interpretation of ^{3}H results are often qualitative due to processes that influence ^{3}H concentrations. Actual ^{3}H concentrations could be the result of 1) recent low-concentration recharge, 2) older "bomb" ^{3}H that has decayed to the measured levels, or 3) a mixture of young and old ground water.

Carbon-14 provides information regarding the number of years that have elapsed since the ground water recharged. A direct estimate of age from the ^{14}C analysis overestimates actual age due to geochemical processes in ground water flow that act to reduce concentrations of ^{14}C and make the water appear older. Some of the processes that act to reduce ^{14}C include reactions with carbonate and silicate rocks, sulfate reduction, and methanogenesis.

Carbon-13 (^{13}C), a naturally occurring stable isotope of carbon, is sometimes used in conjunction with chemical and mineralogic data to evaluate chemical reactions that occur in aquifers and to adjust ages determined from ^{14}C analysis. These chemical and mineralogic reactions may add carbon that does not contain ^{14}C to the dissolved phase or remove carbon that may contain ^{14}C from the dissolved phase. Carbon-13 data are expressed in delta notation (δ) as per mil (parts per thousand) differences relative to the ratio of ^{13}C to ^{12}C in a standard Peedee belemnite (PDB) reference. The large range of $\delta\ ^{13}C$ in various carbon reservoirs is largely a result of carbonate geochemistry and isotope selectivity by bacteria.

Understanding the distribution of isotopes in the carbon cycle begins with carbonate geochemistry. Soil water typically exhibits a $\delta\ ^{13}C$ in the range of –22 to –24 due to CO_2 generated from decaying vegetation. Reactions of CO_2 with carbonate rocks act to enrich ^{13}C or increase the $\delta^{13}C$ to a level of about –12.7 expected for an equilibrium with calcite at a pH of about 7.6 (Clark and Fritz 1997a). Further ^{13}C enrichment can occur at higher pH and with dissolution of dolomite. The $\delta^{13}C$ observed at most of the analysis area springs was in the range of –12.6 to –10.8. Carbon-13 results have been used to try and adjust ^{14}C ages. However, the corrections result in over correction to the ^{14}C ground water age because of insufficient information to model reactions that add or remove carbon from ground water along flow paths that represent different geochemical settings in the analysis area. The corrections were based on the assumption that the presence of dissolved carbonate species originated from calcite dissolution along the flowpath and is presumed to be ^{14}C free. Both the North Horn and Flagstaff formations are comprised of significant amounts of limestone. Additionally, secondary calcite cements are typically found in sandstone, siltstone, and shale formations. The dissolved inorganic carbon (DIC) isotope ratios ($\delta^{13}C$) typically increase as carbonate is dissolved and result in a dilution factor of approximately 85 percent (Clark and Fritz 1997a). Dilution calculations were carried out using the $\delta^{13}C$ values. The equation used to calculate the dilutions is based on the measured DIC $\delta^{13}C$ values measured from field samples and empirical $\delta^{13}C$ values for soil CO_2 (-14 to -23 ‰) and calcite (0 ‰) available for dissolution (Equation 1). Common values used in Equation 1 including $\delta^{13}C$ values for soil CO_2 and calcite are found in Clark and Fritz (1997a) However, these values may not reflect values that correctly represent the hydrogeologic system in the Greens Hollow tract. Reviewing the $\delta^{13}C$ of soil CO_2 values as a function of pH indicates a value closer to -15 ‰ with pH values near 7.5 (Clark and Fritz 1997b). The results indicate the potential for dilution from ^{14}C free carbonates is easily attributable to less than 100 percent modern carbon (PMC) associated with the samples. The amount of error in this type of analysis and lack of sufficient data make it difficult to determine exact values.

Equation 1
$$dilution = \frac{\partial^{13}C_{DIC} - \partial^{13}C_{carbonate}}{\partial^{13}C_{Soil-CO_2} - \partial^{13}C_{carbonate}}$$

Tritium and ^{14}C were also used previously to evaluate mean residence time (age) of ground water in the Pines Tract Area and the SUFCO Mine area. Based on comparison of the ^{14}C and ^{3}H compositions in SUFCO Mine ground water with near-surface ground water, it was determined that a hydrologic disconnect exists between near-surface ground water systems and ground water systems encountered in the SUFCO Mine (Mayo and Associates 1999). Ground water inflows collected in the mine have mean ground water residence times of 7,000 years to 20,000 years and contain no ^{3}H, while near-surface ground waters have modern ^{14}C and abundant concentrations of ^{3}H. Carbon-14 and ^{3}H data were collected from nine springs and two creek segments in the Pines Coal Lease Tract (Mayo and Associates 1998). Abundant ^{3}H and anthropogenic ^{14}C content in ground waters discharging from the Castlegate Sandstone indicated that ground water at these springs recharged during the last 50 years. Two of the Blackhawk Formation springs also had consistent modern isotopic contents. The three other Blackhawk Formation springs that were sampled showed small amounts of ^{3}H (0.08-0.74 TU) and indicated uncorrected radiocarbon ages of 500 years to 4,000 years. The apparent inconsistency in these results was attributable to the dilution by ^{14}C free carbonate dissolution as indicated by $\delta^{13}C$ values for DIC. Due to a lack of data, mixing of older and modern ground waters discharging from these springs cannot be ruled out as a possible reason for the discrepancy.

For qualitative evaluation, the ^{3}H and ^{14}C measured from springs in the Greens Hollow tract are plotted in Figure 8. These results show that water issuing from most springs in the analysis area contains ^{3}H and is considered to be of relatively recent recharge despite having unadjusted ^{14}C ages ranging from zero to 1,910 years. Although measurements of unadjusted ^{14}C could reflect mixtures of older ground water it is typical for dilutions of 85 percent to occur due to carbonate dissolution and is most likely the reason for lower than 100 percent pmc carbon values. However, the water issuing from Price River Formation spring M_SP18 is much older than ground water issuing from the other springs based on the absence of ^{3}H and the older unadjusted ^{14}C age of 1,910 years.

The stable isotopes of hydrogen (^{2}H) and oxygen (^{18}O) are naturally occurring components of water in the hydrologic cycle. The ratios of $^{2}H/H$ and $^{18}O/^{16}O$ change during evaporation and condensation. These ratios also change during ground water transport through the process of mixing and dispersion with other water sources. Interpretation of changes in isotope ratios in ground water can help identify flow paths and recharge sources. The stable isotope ratios of $^{2}H/H$ and $^{18}O/^{16}O$ in water samples are expressed in terms of per mille difference (δ ‰), with respect to an international standard for Vienna Standard Mean Ocean Water (VSMOW):

Equation 2 $\delta ‰ = \{(R\ sample/Rvsmow)-1\}x1000$

where R is the isotope ratio $^{2}H/H$ or $^{18}O/^{16}O$. A sample which has a $\delta\ ^{18}O$ of -15 has an ^{18}O content of 0.015 less than that of the reference standard, VSMOW. Evaporation changes the isotope composition, as the lighter molecules of water, $H_2{}^{16}O$, are more volatile than the heavier water molecules containing the isotopes ^{2}H and ^{18}O. Thus, water vapor that evaporates from the ocean at 25 °C features a δ ‰ of ^{18}O of –9.3 and a δ ‰ of ^{2}H of -76 (Clark and Fritz 1997b). When the atmospheric water condenses, the heavier water molecules condense first leaving the residual atmospheric water vapor more depleted in ^{2}H and ^{18}O. Since the degree of condensation increases at lower temperatures, variations in the isotope contents of precipitation are primarily due to temperature effects. The δ ‰ for ^{2}H and the δ ‰ for ^{18}O in precipitation are highly correlated. A plot of this correlation is referred to as the global meteoric water line, a generic line ($\delta\ ^{2}H = 8 * \delta\ ^{18}O + 10$) developed by Craig (1961). Values along the meteoric water line indicate changes due to condensation temperature of precipitation. This usually matches precipitation quite well for coastal areas, but for precipitation in continental interior locations and arid climates, the intercept usually increases while the slope usually remains at eight.

Evaporation processes and sublimation of snow also result in changes in the isotope ratios after precipitation reaches the land surface. Water in lakes and rivers may become enriched in heavy isotopes through evaporation. Evapotranspiration also increases the heavy isotopes in ground water recharge. The isotopic composition of ground water changes through mixing, dispersion and dissolution of oxygen based minerals. If areal recharge is the main component of ground water flow, the isotopic composition of ground water corresponds to the average composition in areal recharge. Likewise, if recharge from a surface water body is the main component of ground water flow, then the isotopic composition of ground water will correspond to the average isotopic composition in the water body as long as there is no significant increase in dissolved ions. Stable isotope analyses can also be used to assess the contribution of cool and warm season precipitation to the recharge budget, and to evaluate the timing and extent of evaporation during recharge. For example, cool season precipitation in the Sierra Nevada Mountains (mostly snowfall) has an average deuterium value that is 40 to 70 permil lighter than average summer rainfall (Rademacher et al 2002).

The δ ‰ for ^{2}H and the δ ‰ for ^{18}O for each sampled spring are plotted in Figure 9. Without analysis of the δ ‰ for ^{2}H and the δ ‰ for ^{18}O measured in precipitation at various times of the year, it is not possible to determine the local meteoric water line for interpreting the spring results. The global meteoric water line from Craig (1961) and the local meteoric water line for snow in Yellowstone are shown on Figure 9. Deviation to the right of the meteoric water line indicates the relative extent of enrichment of ^{18}O due to evaporation of water and sublimation of snow. Deviations to the left of the local meteoric water line are less common but could occur as a result of recharge of ground water from snow that includes a water component from condensation on cold snow surfaces or from earlier climates that had a different local meteoric water line.

The results in Figure 9 show varying degrees of evaporation or sublimation influences at most of the springs. The results for spring M_SP08 and M_SP18 are slightly right of the local meteoric water line for snow in Yellowstone, indicating that evaporation or sublimation influences may have been minimal for the recharge sources for these springs. The results also show that the water issuing from springs in the analysis area are predominantly recharge that originates from snow, with perhaps slight but varying degrees of contribution from warm period precipitation. The water isotopes also show no ^{3}H in M_SP18 and less ^{14}C, indicating older ground water. The apparent age based on ^{14}C may not be as old as indicated in Figure 8 due to dissolution of carbonates that are low in ^{14}C. The water isotopes from M_SP18 also show relatively depleted values when compared to the other springs (M_SP01, M_SP02, M_SP04, M_SP07, M_SP08, and M_SP14) indicating a potentially colder temperature at the time or area of recharge. This could be related to a different time period with a cooler temperature or water from a different recharge area of colder temperatures.

3.1.1.1 Springs and Ground water in the Flagstaff Formation

The Flagstaff Limestone is the uppermost consolidated formation near the analysis area, located west of the analysis area boundary. The spring and seep survey for the Greens Hollow project found no ground water issuing from the Flagstaff Formation.

3.1.1.2 Springs and Ground water in the North Horn Formation and Landslide Deposits Overlying the North Horn Formation

The majority of the springs identified in the analysis area were issuing from the North Horn Formation. The North Horn Formation is estimated to be up to 1,490 feet thick in the analysis area based on the geologic report by Anderson (2004). No drilling in the area has penetrated both the upper and lower contacts of the formation. The shaley nature of the formation and its occurrence at higher elevations that receive more precipitation makes it vulnerable to mass movement, slope failures, and landslides. The shales and clays of the North Horn Formation serve to retard the vertical flow of water causing ground water to move horizontally along bedding planes or through fractures. It is uncertain whether ground water aquifers in the North Horn and Upper Price River Formations are continuously saturated or whether unsaturated zones occur beneath perched saturated zones. Indications of extensive unsaturated horizons in the Price River and Castlegate Sandstone in drill-holes and wells in the adjacent SUFCO Mine and Pines Lease Tract, as reported in the Pines Tract EIS, suggests that perched ground water conditions are likely. In any event, it is clear that the clays and shales in the North Horn and Price River Formations severely restrict vertical flow of ground water to deeper units in the analysis area as indicated by the large number of springs in these units and the occurrence of only one spring, M_SP87, in the underlying Castlegate Sandstone.

The springs in Figure 5 appear to have no preference as to slope direction. Anderson (2004) observed a similar lack of pattern for the location of landslides and slumps relative to slope directions. The diameter of the circles associated with each spring in Figure 5 shows the flow range for both maximum and minimum flows measured during the baseline monitoring period. Most of the springs issuing from the North Horn Formation were either seasonal springs exhibiting very low flows during the late summer and fall or exhibited very low flow throughout the year. As mentioned above in Section 2.4.4, a review of annual streamflow from Muddy

Creek and precipitation levels recorded at nearby SNOTEL stations, indicate that water year 2002 (October 1, 2001 through September 30, 2002) was well below historic averages and in the lower tenth percentile of historic annual precipitation totals (USGS 2013, USDA-NRCS 2013).

Monitoring results for field parameters for the North Horn Formation springs are summarized in Table 2. These results are compared with relevant water quality standards for surface waters located in the analysis area. These standards are found in R317-2, Utah Administrative Code(UAC). The Utah DWQ has classified surface waters in the analysis area as:

- 1C – raw water source for domestic water systems
- 2B - protected for secondary contact recreation.
- 3C - protected for nongame fish and other aquatic life
- 4 - protected for agricultural uses including irrigation and stock watering.

The relevant water quality criteria for field parameters in surface water in the analysis area are: $6.5 > pH < 9$; temperature $< 27^{0}$ C; and dissolved oxygen > 3.0 mg/l. It should be noted here that the 3C beneficial use classification is used for springs in preference to class 3A – cold water aquatic life. Generally speaking, the 3C classification is considered to protect forms of aquatic life that include nongame fish as well as non-fish aquatic species such as amphibians and macroinvertebrates. This assessment assumes that the topographical locations and discharge rates from springs in the analysis area would not support fish populations, therefore measured water quality parameters from springs are compared to the 3C classification.

The results in Table 2 show that water from all North Horn Formation springs meets the relevant pH and temperature criteria but that many of the dissolved oxygen values do not meet relevant water quality criteria. This is not unexpected, because the spring water is derived from ground water that is typically very low in dissolved oxygen.

North Horn Formation springs M_SP04, M_SP07, M_SP08, and M_SP14 were also sampled for water quality analysis as well as monitored for field parameters. Monitoring results from individual springs are described below. A summary of the laboratory analysis results for all four of the North Horn Formation springs is included in Table 3, which provides a comparison with relevant water quality criteria for inorganic constituents and dissolved metals. The relevant aquatic criterion for ammonia nitrogen depends upon temperature and pH and the relationship is tabulated in R317-2, UAC. Monitoring of total manganese and total iron is required by Utah DOGM rules, although there is no Utah water quality standard for either of these parameters.

The Table 3 results show that all North Horn Formation Springs and the springs issuing from landslide deposits overlying the bedrock of the North Horn Formation generally meet the relevant criteria and pollution indicator values associated with each constituent. Occasional violations of the Class 1, Class 3, and Class 4 criteria were noted at two springs for arsenic (one violation) and selenium (two violations). All violations occurred on the same sample date. The remaining measurements of arsenic and selenium are well below numeric criteria. It is assumed the limited number of water quality violations observed at these springs are within the normal range of water quality variations and do not indicate impairment. The results shown in Table 3 provide a baseline for comparison with water quality monitoring results obtained in the future.

Spring M_SP04 issues from the North Horn Formation in a small drainage to the south of Greens Hollow, on the west side of the Tract. The slope above the spring appeared to be stable with no indications of slumping/soil movement. Time series plots of flow, field parameters, and Stiff diagrams of major ion chemistry for this spring are provided in Figure 10. These results show modest seasonal fluctuation in flow and field parameters. Flows ranged from less than 1 gpm to about 3 gpm. Specific conductance ranges from about 380 to 930 uS/cm and did not appear to correlate with the measured flow rate. The spring water is a mixed cation bicarbonate water with sodium being the dominant cation. It exhibits consistent ion chemistry that does not change with flow or specific conductance.

Spring M_SP07 is located on the boundary of the Greens Hollow tract and issues from the base of the North Horn Formation near the outcrop of the Price River Formation. Water from this spring flows from the base of a slump down to a wide, flat-bottomed drainage swale connected to Cowboy Creek. This water forms a small wet pocket at the bottom of the drainage but does not reach Cowboy Creek. Time series plots of flow, field parameters, and Stiff diagrams of major ion chemistry for this spring are provided in Figure 11. These results show slight seasonal fluctuation in flow and field parameters. Flows generally ranged from about 0.2 gpm to about 0.6 gpm, although a flow of 1.14 gpm was measured on June 20, 2001. Specific conductance ranged from about 440 to about 880 uS/cm and did not appear to correlate with the measured flow rate. The spring water is a mixed cation bicarbonate water. It exhibits consistent ion chemistry that does not change with flow or specific conductance.

Spring M_SP08 issues from the North Horn Formation and is located toward the south east portion of the Tract. This is a developed spring that feeds a spring box and a cattle trough. Time series plots of flow, field parameters, and Stiff diagrams of major ion chemistry for this spring are provided in Figure 12. These results show seasonal fluctuation in flows. Flows ranged from 0 to about 1.2 gpm. Specific conductance and conductance ranged from about 330 to about 1,000 uS/cm and did not appear to correlate with the measured flow rate. The spring water is a mixed cation bicarbonate water.

Spring M_SP14 is located near the head of Cowboy Creek to the west of the Greens Hollow tract. Spring M_SP14 is developed for water supply and supports a spring box located about 50 feet downstream from the source and a cattle trough, located about 250 feet down slope. Water from the spring and overflow from the trough, flow down into small tributary drainages of Cowboy Creek. Time series plots of flow, field parameters, and Stiff diagrams of major ion chemistry for this spring are provided in Figure 13. The discharge is highly variable and seasonal with high flow rates noted in May or June of 2001, 2003, and 2004 and discharge drying up in the fall of the year. The maximum discharge rate noted was 61.4 gpm in May 2004. Specific conductance ranged from about 300 to about 540 uS/cm with the lower specific conductance corresponding with the higher flow rates. The spring water is a calcium bicarbonate water which did not vary among the samples collected.

3.1.1.3 Springs and Ground water in the Price River Formation and Landslide Deposits Overlying the Price River Formation

The lithology of the Price River Formation is genetically similar to the underlying Castlegate Sandstone but the formation contains finer-grained clastics or more shale and siltstone, with minor conglomerate. The unit is semi-resistant and generally a slope-former (Anderson 2004). Like the North Horn Formation, the outcrop of the Price River Formation is susceptible to slumping and landslides due to the occurrence of shales and clays.

Laboratory measurements of spring discharge from the Price River Formation are summarized in Table 4 and compared to relevant water quality standards. Figure 5, Figure 6, and the summary in Table 2 show that springs issuing from the Price River Formation generally exhibit higher levels of specific conductance and lower flow rates as compared to the springs issuing from the

North Horn Formation. Table 2 results also show that water from all Price River Formation springs meet the relevant criteria for pH and temperature but do not meet relevant criteria for dissolved oxygen. The low dissolved oxygen values are to be expected as ground water is typically very low in dissolved oxygen.

The highest flow from Price River Formation springs was observed at Spring M_SP02. Price River Formation Springs selected for baseline water quality analysis included Springs M_SP01, M_SP02, M_SP18, and M_SP39.

Spring M_SP01 is located along Greens Hollow, at Rough Brothers cabin. The spring was developed sometime during 1930-40 and has been used for culinary and irrigation purposes at the cabin since that time. Discussions held with the owner of the cabin during the Muddy Creek Tract survey, indicated that flow from the spring has been steadily dropping from 1999- 2004 due to drought conditions. Time series plots of flow, field parameters, and Stiff diagrams of major ion chemistry for this spring are provided in Figure 14. These results show slight seasonal fluctuation in flow and field parameters. Flows generally ranged from about 0.2 gpm to about 0.9 gpm. Specific conductance ranged from about 435 uS/cm to slightly over 900 uS/cm and did not appear to correlate with the measured flow rate. The spring water is a mixed cation bicarbonate water with calcium being the dominant cation similar to Spring M_SP02. It exhibits consistent ion chemistry that does not change with flow or specific conductance.

Spring M_SP02 is located near the Greens Hollow stream crossing and provides water for a cattle trough located about 100 feet to the east and eventually for pond P1. Time series plots of flow, field parameters, and Stiff diagrams of major ion chemistry for Spring M_SP02 are provided in Figure 15. The Emery Water Conservancy District (EWCD) is also monitoring flow at this spring. The daily flow summaries for the time period from July 3, 2002 through November 14, 2003 are also plotted in Figure 15. These results show some differences between the continuous flow measurements by the EWCD and the seasonal manual flow measurements taken at the time of sampling for baseline characterization for this study. As discussed previously, some of the discrepancy may be explained if the EWCD flow monitors are not capable of detecting low flows. However, at this location, a zero flow was reported by the EWCD gauge on May 20, 2003 while a flow measurement of 6.86 gpm was recorded at the spring box. On the same date, a flow measurement of 0.57 gpm was recorded by Cirrus at the pipe entering the cattle trough, which is the same location as the EWCD gage. The EWCD meters may have also been disturbed by ranch hands during maintenance of the spring box and cattle trough. Manual flow measurements at this spring suggest seasonal fluctuations with flows ranging from 0 to about 13.4 gpm. Specific conductance is fairly constant at this spring and ranges from 469 to 499 uS/cm for the 2001 to 2004 with specific conductivity increasing to the 800 uS/cm range for measurements in 2006 and 2007, with no correlation with flow rates. The spring water is a mixed cation bicarbonate water with calcium being the dominant cation. It exhibits consistent ion chemistry that does not change with flow or specific conductance.

Spring M_SP18 is a developed spring located at the south end of a wide, gently sloped tributary to Muddy Creek. The spring box is heavily corroded. Its outlet appeared to be plugged or partially plugged during some of the sampling visits and water inside the spring box looked stagnant. At one time, this spring box was connected to a cattle trough. During the Muddy Creek Tract survey, the line was broken just below the cattle exclosure surrounding the spring box. Another large cattle trough located approximately ¾ mile north of the spring may have also been filled by this same spring. It was dry during the baseline monitoring period. Time series plots of flow, field parameters, and Stiff diagrams of major ion chemistry for this spring are provided in Figure 16. These results show seasonal fluctuation in discharge with flows ranging from 0 to about 0.5 gpm. Specific conductance ranged from 726 to 1,435 uS/cm and did not appear to correlate with the measured flow rate. The spring water is a mixed cation mixed anion water. The changes in specific conductance and changes in anion composition observed at this spring may be due to the poor condition and maintenance of the spring box, including the corroded condition, stagnant water, and dead animals that were occasionally found in the spring box.

Spring M_SP39 is located in the Greens Hollow tract, adjacent to Cowboy Creek. It is developed, with a series of three spring boxes. The top spring box is disconnected and does not appear to be flowing anymore (water in the spring box appeared to be stagnant). The middle spring box discharges into the lower spring box, which discharges into Cowboy Creek. Time series plots of flow, field parameters, and Stiff diagrams of major ion chemistry for this spring are provided in Figure 17. The EWCD has monitored flow at this spring. The daily flow summaries for the time period from July 3, 2002 through November 14, 2003 are also plotted in Figure 17. These results initially show good agreement with the manual measurements, with discrepancies starting to appear in November 2002. As noted, some discrepancy may be explained if EWCD flow monitors are not capable of detecting low flows. Furthermore, the initial agreement between manual and instrument measurements followed by a period of disagreement seems to indicate tampering by humans. The manual measurement results show large seasonal fluctuation in flows. Flows ranged from 0.27 to 4.66 gpm. Specific conductance ranged from 573 to 1,035 uS/cm with higher values occurring at the lower measured flow rates. The spring water is a mixed cation bicarbonate water.

Laboratory analysis results for all four Price River formation springs are compared with the relevant water quality criteria for inorganic constituents and dissolved metals in Table 4. These results show the Price River Formation springs that were sampled for baseline water quality generally met all relevant criteria for all constituents except for slight exceedances of arsenic, cadmium, lead, TDS, and zinc

Arsenic exceeded the 1C standard of 0.01 mg/l for one of six sample dates at two spring monitoring sites. Factors contributing to a higher concentration on this date (November 2002) are not known at this time. However, it is assumed these violations do not characterize typical fluctuations in water quality from these springs. All other measurements from these springs were well below the 1C standard. As a result, it is assumed these violations do not represent water quality impairment.

All measurements of cadmium and lead were below the Method Detection Limit (MDL) used to measure each sample including 0.005 mg/l and 0.07 mg/l, respectively. Due to the slight differences between water quality standards and the laboratory's MDL for each parameter, it is not possible to determine if these measurements exceed the associated 1C, 3A and 3C standards. However, based on local knowledge of geology, soil, and land use/development in the analysis area, it is likely that water chemistry at these sites generally reflects natural conditions, is not a danger to animal or human health, and is in support of the assigned beneficial use.

Measurements of TDS and zinc both had single measurements that exceeded water quality standards including a TDS measurement of 1,214 mg/l collected from Spring M_SP39 on May 12, 2004 and a zinc value of 0.13 mg/l collected from Spring M_SP01 on October 7, 2003. It is assumed these single violations do not indicate water quality impairment at either spring.

3.1.1.4 Springs and Ground water in the Castlegate Sandstone

The Castlegate Sandstone forms a steep cliff escarpment along most stream valley segments of Muddy Creek, Box Canyon, and Greens Canyon. This unit is between 195 and 326 feet thick, with an average thickness of 239 feet (Anderson 2004). Near cliff exposures and in stream bottoms, the Castlegate Sandstone becomes friable due to the dissolution of the carbonate cement thus becoming more capable of supporting active ground water systems (USDA-FS 1999).

Spring M_SP87 is the only Castlegate Sandstone spring identified in the Greens Hollow tract. It issues from the base of an overhanging cliff at the contact with the Blackhawk Formation at an elevation of about 250 feet above the south side of Muddy Creek. Flows at this spring ranged from about 2.2 to about 3.1 gpm with little seasonal fluctuation. Specific conductance ranged from 627 to 1,277 uS/cm with no correlation with the flow rate. Spring M_SP87, like other Castlegate Sandstone springs in the Muddy Creek Tract analysis area and Pines Coal Tract, issues from the base of the sandstone at the contact with the Blackhawk Formation, where the occurrence of abundant swelling clays serves to impede downward movement of ground water, causing lateral movement. Structure appears to influence ground water flow in the Castlegate Sandstone in the Muddy Creek Tract analysis area as all of the springs are located on the east or southeast side of the canyons, as would be expected for ground water following the dip slope. No springs were found to issue from the Castlegate Sandstone in Greens Canyon. This suggests that either the recharge area between Greens Canyon and Box Canyon is insufficient to sustain ground water flow in the downdip direction in the Castlegate Sandstone or that an absence of shales and swelling clays in the upper part of the Blackhawk Formation in this area does not allow ground water levels to rise sufficiently to sustain spring flows.

Ground water issuing from spring M_SP87 exhibits much higher levels of specific conductance than Castlegate Sandstone springs located in Box Canyon that were measured during monitoring of the Muddy Creek Tract. Spring M_SP87 also exhibits a somewhat higher pH that is similar to the Price River Formation. These results, together with consistent flow from the spring, suggest that recharge for the spring passes through the Price River Formation. Spring M_SP87 is located near the mouth of an unnamed tributary to Muddy Creek. It is likely that much of the recharge for this spring occurs along this stream valley.

3.1.1.5 Springs and Ground water in the Blackhawk Formation

The average thickness of the Blackhawk Formation in the analysis area is 825 feet with a minimum thickness of 714 feet. The mineable coal is found in the lower quarter of the formation (Anderson 2004). The sandstone units become more separated and isolated towards the base of the Blackhawk. The interbedded claystones, siltstones, and sandstones of the Wasatch Plateau are rich in swelling clay minerals of the montmorillonite or smectite group. Material from the Blackhawk Formation was examined by X-ray diffraction and found to contain an average of 24 percent smectite, a swelling clay. (DOGM 1992) These swelling clays decrease the vertical hydraulic conductivity, which impedes the vertical flow of ground water in the Blackhawk Formation. No springs issuing from the Blackhawk Formation were noted in the analysis area.

3.1.1.6 Springs and Ground water in the Star Point Sandstone

The upper Star Point Sandstone consists of three massive sandstone layers (USDA-FS 1999); the lower Star Point Sandstone is an upward prograding sequence of thin sandstones, siltstones, and shales, which intertongue with the underlying Masuk Member of the Mancos Shale (USDA-FS 1999). The Masuk member of Mancos Shale acts as a low permeability base or boundary such that Star Point Sandstone is the lowermost ground water bearing bedrock formation evaluated in this study. The Muddy Creek Tract spring and seep survey found no ground water issuing from the Star Point Sandstone, including the Greens Hollow tract. As discussed in Section 2.2, Thiros and Cordy (1991) conducted a gain-loss study of North Fork Quitchupah Creek that found an increase in flows where the creek crossed the Star Point Sandstone outcrop. The Pines Tract EIS determined that recharge of the Blackhawk formation and underlying Star Point Sandstone is quite low and occurs primarily in the vicinity of the outcrops (USDA-FS 1999).

3.1.1.7 Ground water in Alluvium

Thin alluvial deposits are found along the bedrock-dominated channels in the canyon bottoms. Mapped alluvial deposits occur along Muddy Creek below Box Canyon, east of the analysis area. Muddy Creek does have a floodplain and unmapped alluvial deposits along most of the stream channel in the analysis area. Although ground water undoubtedly occurs in the alluvium of Muddy Creek, ground water levels would vary seasonally with flows in the creek. Ground water in the alluvium does not support any direct use for wells. However, the alluvium likely serves to store surface runoff water during high flows and release water as levels in the creek drop, helping maintain perennial flow in the lower portions of the Muddy Creek Canyon. Muddy Creek's gradient, as measured from the USGS 7.5-minute topography, averages about 3 percent in this area.

The Office of Surface Mining and Reclamation (1985) has prepared reconnaissance maps to assist in identifying Alluvial Valley Floors for the coal regions of central Utah. These maps show no subirrigated alluvium or potentially flood irrigable alluvium in the analysis area.

The Utah DOGM has also made a negative determination on the existence of unconsolidated stream laid deposits holding streams and sufficient water to support agricultural activities in the SUFCO Mine Plan Area and adjacent area. This area and determination includes Muddy Creek and the North Fork Quitchupah Creek.

3.1.1.8 Ground water Summary

The general pattern for ground water flow in the vicinity of Greens Hollow is from recharge areas at the higher topographic elevations to discharge areas at the lower topographic elevations along the stream valleys. Of course, the site geology controls the patterns, pathways and rates of ground water flow. Ground water recharge and discharge is localized in the North Horn and Price River Formations. These geologic units contain the majority of springs found in the analysis area. The location of springs has no apparent relationship with geologic structure and no preference as to the slope direction. It is apparent that clays and shales in the North Horn and Price River Formations restrict vertical flow of ground water to deeper units in the analysis area, causing the springs to appear at higher topographic positions.

Geologic structure appears to influence the location of springs issuing from the Castlegate Sandstone. Spring M_SP87 is the only Castlegate Sandstone spring in the Greens Hollow tract. This spring is located south of Muddy Creek on the north side of the coal tract and exhibits much higher specific conductance than the other Castlegate Sandstone springs located east of the analysis area in the Box Canyon drainage and a somewhat higher pH that is similar to the Price River Formation. These results, together with the consistent flow of the spring, suggest the recharge for this spring passes through the Price River Formation. Spring M_SP87 is located near the mouth of an unnamed tributary to Muddy Creek and it is likely that much of the recharge for this spring occurs along the stream valley.

No springs were identified that discharge from the Blackhawk Formation in the Greens Hollow tract.

The assessment and discussion of measured flows in the above sections is not meant to assign significance or importance to certain springs based on discharge volumes or length of flow. All springs in the analysis area are considered important. However, some springs can be considered to have a higher value as a result of investments in development or due to the support provided by these springs to dependent ecosystems. Systematically identifying the values associated with individual springs can provide guidance for mine plan development and/or mitigation measures. While it is unlikely that mining developments can occur in a way that would avoid all springs, some knowledge of the value of individual springs could be used to design a practical mine plan with a relatively high probability of minimizing impacts on high value springs. Springs located adjacent to wetlands are a significant source of water to vegetation and wildlife that utilize these areas as primary or secondary habitat. Improvements to livestock management can result following spring development as animals are drawn to troughs located away from fragile areas of ground water discharge. Springs located in upgradient source areas for wetlands and riparian corridors can be some distance away, yet still provide seasonal or perennial flows that support these features. The following factors were used to define the value of each spring in the analysis area.

> High Value: Springs that are located within 25 feet of wetland areas, provide surface tributary flow to the adjacent wetland, or developed in support of human or livestock use.
>
> Moderate Value: Springs located within 500 feet of wetland areas or riparian corridors.
>
> Unknown Value: Springs not classified as High or Moderate Value.

Table 5 and Figure 4 indicate the classification of each spring. Note that four springs were classified as Unknown value. The remaining springs are either located in source areas, adjacent to wetlands and riparian corridors, or provide tributary support to these features. A total of 14 springs were classified as High value and 15 springs were classified as Moderate value. A total of eight springs in the analysis area have been developed for human use (Rough Brothers of the Hills cabin) or livestock use. Additional detail on vegetation and wildlife species that depend on springs as a primary source of water is provided in their respective sections of the Greens Hollow SEIS.

3.1.2 SURFACE WATER

Surface water resources include streams and associated floodplains, reservoirs, stock ponds, and springs. As springs are a surface manifestation of ground water, they are described above in Section 3.1.1. The remaining surface water resources are described in detail below.

The mine plan indicates that North Fork Quitchupah Creek would receive discharge associated with mining of the Greens Hollow tract. The northern and central portions of the Tract drain into Muddy Creek while the southern portion of the Tract drains into North Fork Quitchupah Creek as shown in Figure 1. The remaining area of the Tract is comprised of portions of several drainages that contribute flow to Muddy Creek or North Fork Quitchupah Creek. These drainages include North Fork Muddy Creek, South Fork Muddy Creek, Horse Creek, and several unnamed tributaries. Major drainages located adjacent to the Greens Hollow tract include North Fork Muddy Creek, Horse Creek, Box Canyon, lower North Fork Quitchupah Creek, and South Fork Muddy Creek. The divide between the Muddy Creek and North Fork Quitchupah Creek drainages is locally known as Big Ridge and extends across the southern end of the analysis area. This feature separates headwater areas of Cowboy Creek and North Fork Quitchupah Creek. The headwater areas for Greens Hollow, Cowboy Creek, and North Fork Quitchupah Creek extend to the west of the Tract.

The mainstem of Muddy Creek is perennial as it passes across the northern end of the Greens Hollow tract. During 2001-2004, Greens Canyon contributed seasonal flow into the mainstem of Muddy Creek, while upper portions of Cowboy Creek and Greens Hollow were noted to be perennial. North Fork Quitchupah Creek is the only perennial stream located within the Greens Hollow tract that does not flow into Muddy Creek. The extent of perennial flow was observed during the fall of 2001 through 2003. The most extensive coverage of perennial flow was observed during fall 2001 and was used to assess impacts on perennial streams. The extent of perennial streams observed during the fall of 2001 is shown in Figure 4. By definition, perennial stream channel segments contain flowing water throughout each year. In order for flows to be maintained outside of periods of surface runoff, ground water must intersect perennial stream channels in amounts that offset any loss to seepage (Mosley and McKerchar 1993). The amount and extent of perennial flow is therefore influenced by annual precipitation levels, surface runoff, and shallow ground water recharge. As mentioned above in Section 2.4.4, annual streamflow levels recorded from Muddy Creek indicate that water years 2001-2003 were below historic averages. Based on all available, approved records, the historic (1952-2012) annual average for Muddy Creek near Emery is 37.5 cfs (USGS 2013). Annual average streamflow during the 2001 water year was 33.2 cfs or approximately 11 percent lower than the historic average.

Baseline stream monitoring stations were established at several locations along Greens Canyon (M_STR1, M_STR2), Greens Hollow (M_STR6), and Cowboy Creek (M_STR3, M_STR4, M_STR5) as shown in Figure 4. Additional monitoring locations were established on the South Fork Muddy Creek just above its confluence with the North Fork Muddy Creek (M_STR8) and on the unnamed tributary that enters Muddy Creek near the north boundary of the analysis area (Figure 4). Other monitoring has been performed by the SUFCO Mine at two locations on North Fork Quitchupah Creek inside the analysis area including M_STR9 and M_STR10 (Figure 4).

Table 6 summarizes field measurements of water quality for each station. These results are described in more detail in the following sections for individual drainages. The statistics in Table 6 are based on visits when flow was measured. In addition to periodic monitoring, continuous flow measurements were collected at six stream monitoring stations on Greens Canyon and its tributaries. These measurements are described in more detail below.

3.1.2.1 Muddy Creek

As it traverses the northern edge of the analysis area Muddy Creek flows in a narrow, deep canyon with steep cliffs formed by the Castlegate Sandstone. Below its confluence with lower Box Canyon Creek, the valley bottom becomes somewhat wider (averaging about 300 feet) and the sinuosity of the channel increases. However, the channel is still entrenched, and is confined in a narrow valley bottom. Mapped alluvium and a small floodplain occur in this reach below Box Canyon. As defined by the extent of Castlegate Sandstone outcrops, cliff escarpments may extend upstream along both sides of Muddy Creek above the confluence of North Fork and South Fork Muddy Creek (Anderson 2004).

Muddy Creek has been gauged by the USGS at Station 09330500, located about 5 miles downstream of the analysis area and about 4 miles north of the town of Emery. The drainage area above this gage is reported to be 105 square miles by the USGS but was determined to be 108.8

square miles in this study. Muddy Creek is a source of drinking water and irrigation water for the town of Emery. Annual average discharge at this gage for water years 1953 through 2012 (October 1952 through September 2012) is 37.5 cubic feet per second (cfs) (USGS 2013). Variations in annual discharge were common with a low mean discharge of 9.4 cfs reported for water year 1977 and a high mean discharge of 86.1 cfs in water year 1983. The baseline monitoring period for the Muddy Creek Tract study began in the summer of 2001, just before the beginning of water year 2002, and extended through June 2004. The average annual flows for water years 2002 and 2003 were 18.4 and 31.8 cfs, respectively, which are below the average annual flow for the period of record as indicated in Figure 18.

Flows are seasonal with the highest monthly flows occurring as a result of snowmelt runoff in May and June and the lowest monthly flows occurring in December, January, and February, as indicated in Figure 19. There is a vast difference between the highest and lowest monthly flows for the period of record, particularly during the peak snowmelt runoff months of May and June, as indicated in Figure 19. Monthly flows during the baseline water year 2002 were well below the corresponding average flows for all months. Monthly flows during water year 2003 matched the average monthly flows quite closely, although all months except March 2003 were below the period of record average flow.

Intense summer thunderstorms occasionally result in short-term flash flooding that produce high peak flows but not large volumes of runoff. Peak flows for various return periods were determined for the USGS Station 09330500, located on Muddy Creek about 5 miles downstream of the analysis area. Two methods were used for estimating flood flow frequency, including the regional regression analysis methods for ungaged locations as outlined in "The National Flood-Frequency Program—Methods for Estimating Flood Magnitude and Frequency in Rural Areas in Utah" (Mason et al. 1999) and a log-Pearson Type III Frequency Analysis of the 60 years of annual maximum flow data available for the USGS Station 09330500 on Muddy Creek. The flood frequency results for this location determined from each of these methods compare favorably as indicated in Table 7 and Figure 20. This provides greater confidence in the frequency results determined for the other relevant drainage basins using the procedures in USGS Fact Sheet 124–9.

Muddy Creek and its tributaries from the Utah Highway 10 crossing to the headwaters has been assigned several beneficial use classifications under Utah legislation R317-2 Standards of Quality for Waters of the State including the following:

- 1C – raw water source for domestic water systems
- 2B – protected for secondary contact recreation.
- 3A – protected for coldwater species of aquatic life.
- 4 – protected for agricultural uses including irrigation and stock watering.

The portion of Muddy Creek and tributaries that are located in the outer boundary of the Manti-LaSal National Forest is classified as a Category 1 - High Quality Water. This segment is subject to stringent antidegradation limits that preclude new point source discharges. Before it is used for domestic purposes, Muddy Creek water undergoes full conventional treatment (USDA-FS 1999). Additional information regarding the use of Muddy Creek as a domestic water source is included below under Section 3.1.4 Drinking Water Source Areas.

Baseline monitoring has been performed at M_STR8 on the South Fork Muddy Creek near the Tract boundary as shown on Figure 4. Monitoring at this station began on 9/26/02. A summary of field monitoring results is provided in Table 6 and Figure 21. A summary of the water quality results is shown in Table 8. Measured flow rates ranged from 968 to 15,644 gpm for the six reported measurements. The baseline water quality results show low TDS and nitrate/nitrite. None of the analyzed parameters exceeded the respective standards.

3.1.2.2 Greens Canyon and Tributaries

Greens Canyon and its primary tributaries, Greens Hollow and Cowboy Creek, drain the majority of the surface of the Greens Hollow tract as shown in Figure 1. The headwaters of Greens Hollow and Cowboy Creek extend slightly west of the coal lease. Baseline stream monitoring stations were established at several locations along Greens Canyon, Greens Hollow, and Cowboy Creek as shown in Figure 1. Moving upstream from the confluence of Greens Canyon and Muddy Creek, the stations are M_STR1, M_STR2, M_STR3, M_STR5, and M_STR4. Station M_STR6 is upstream of M_STR2 in Greens Hollow. A summary of the field measurements for each station is shown in Table 6 and plotted in Figures 22, 23, 24, 25, 26 and 27, including stations M_STR1 through M_STR6, respectively.

Station M_STR1 is located approximately 900 feet above the confluence of Greens Canyon and Muddy Creek. Of the 16 visits reported between 6/6/01 and 5/10/04, the site was dry 13 times. The field and water quality measurements met the standards as shown in Table 6 and Table 9 with the exception of arsenic. Arsenic exceeded the 1C standard of 0.01 mg/l for one of the three sample dates. This violation was equal to the laboratory's MDL and is likely within the normal range of water quality variation experienced in many streams during the spring runoff season. The other two samples were well below the 1C standard. It is anticipated this violation is not indicative of water quality impairment for Greens Canyon and does not pose risks to human or animal health.

Station M_STR2 is located mid-way along Greens Canyon, beginning at the confluence of Cowboy Creek and Greens Hollow and continuing downstream to where Greens Canyon joins Muddy Creek. The stream channel above the station, up to the confluence of Cowboy Creek and Greens Hollow, is primarily bedrock. This station was installed per DOGM request in August 2002 and was monitored eight times between 8/7/02 and 5/10/04. The station was dry only for the first visit, with flows averaging 12.4 gpm and a maximum flow recorded of 74.2 gpm for the six visits before 2004. The 5/10/04 visit reported a flow rate of 460 gpm. All standards and pollution indicator values that were used to evaluate field and laboratory samples were met, as shown in Table 6 and Table 10, with the exception of total phosphorus. Measurements of total phosphorus had a maximum value of 0.12 mg/l and exceeded the pollution indicator value of 0.05 mg/l assigned to Class 2B and Class 3A beneficial uses. The remaining samples were slightly above or below 0.05 mg/l. Visual inspection of the stream channel did not indicate the presence of algal growth and dissolved oxygen measurements were all above desired levels at this station for Class 3A aquatic life forms. Therefore it is likely that nutrient concentrations at this station are not contributing to eutrophic conditions resulting in water quality impairment. Total phosphorus concentrations measured from streams, ponds, and springs in the analysis area are influenced by a combination of natural and anthropogenic sources. Natural sources include stream erosion, wild animal wastes and leaf fall. Anthropogenic sources are primarily livestock manures captured by surface runoff, or deposited directly by grazing animals. The total amount contributed by each source varies according to location, season, precipitation, wildlife population dynamics and grazing management practices. The 0.05 mg/l concentration used to evaluate total phosphorus is a pollution indicator value and not a numeric criteria or water quality standard. Concentrations of total phosphorus greater than 0.05 mg/l are not inherently toxic to human or animal life. Total phosphorus concentrations greater than 0.05 mg/l have potential to contribute to algae growth and eutrophic conditions that result in low levels of dissolved oxygen which are hazardous or even lethal to aquatic life.

Station M_STR3 is located on Cowboy Creek approximately 400 feet above the confluence with Green's Hollow. This station was monitored 16 times between 6/6/01 and 5/10/04. The station was dry for only two of those visits, with flow averaging 8.5 gpm and a maximum flow of 54.9 gpm for the 15 visits before 2004. A flow rate of 491 gpm was reported on the 5/10/2004 visit. It was noted on several visits that flow in Cowboy Creek had dried up shortly downstream of the station. The dissolved oxygen level was measured slightly below 4 mg/l during two visits. Other pollution indicator values and water quality standards were met as shown in Table 6 and Table 11 with the exception of total phosphorus and arsenic. Total phosphorus had a maximum value of 0.13 mg/l which exceeds the 0.05 mg/l pollution indicator value. The median of the remaining total phosphorus samples was 0.05 mg/l. Arsenic was detected in nine of 12 samples at levels that were below the Class 1C standard of 0.01 mg/l. The three remaining arsenic samples were measured using a test associated with a detection limit of 0.1 mg/l. Two of these samples had concentrations < 0.1 mg/l while the remaining sample had a measured arsenic concentration of 0.1 mg/l and equal to the detection limit. It is assumed these violations are not indicative of water quality impairment for Cowboy Creek and do not pose risks to human or animal health.

Station M_STR4 is located in upper Cowboy Creek, where the canyon begins to narrow and become confined. This station was monitored during 37 visits between 6/7/01 and 9/25/12, although laboratory measurements were only collected during 2001-2004. This site was dry during 21 of the 37 visits. The pollution indicator values and water quality standards were all met, as shown in Table 6 and Table 12 with the exception of total phosphorus and arsenic. Total phosphorus had a maximum value of 0.10 mg/l. The five remaining total phosphorus samples were at or below 0.05 mg/l. Arsenic had a maximum value of 0.1 mg/l while four of six total samples that were measured were below the standards associated with Class 1C and Class 3A beneficial use. The remaining sample had a concentration < 0.1 mg/l as defined by the MDL. It is assumed these violations are not indicative of water quality impairment for Cowboy Creek and do not pose risks to human or animal health.

Station M_STR5 is located on Cowboy Creek, approximately 1,150 feet upstream from station STR3. This station was installed per DOGM request in August 2002 and was monitored on eight sample dates between 8/8/02 and 5/11/04. Flow was noted during each visit to the station. This section of Cowboy Creek was observed to be perennial during 2001. Field notes indicated the source of water came from below a large outcrop approximately 300 feet upstream. Flow in the creek ranged from 1.4 to 61.6 gpm for the seven visits before 2004. A flow rate of 598 gpm was reported on the 5/11/2004 visit. The water was relatively cold and highly oxygenated (minimum measurement of 7.23 mg/l). The water quality standards and pollution indicator values were all met as shown in Table 6 and Table 13.

Station M_STR6 is located in Greens Hollow. This station was monitored 16 times between 6/7/01 and 5/11/04 and was dry five times. The field standard for temperature was exceeded two times and the dissolved oxygen standard was exceeded once. The other water quality standards were met, as shown in Table 6 and Table 14. Measurements of total phosphorus showed that five of the nine samples exceeded the 0.05 mg/l pollution indicator value. The maximum value of total phosphorus was 0.14 mg/l and one sample measured 0.10 mg/l. The remaining seven samples were measured slightly above, equal to, or below 0.05 mg/l. Measurements of dissolved cyanide identified two sample measurements in excess of the Class 3A standard of 0.0052 mg/l. The remaining seven samples were below the MDL as well as the Class 3A standard. It is likely these exceedances are in the range of natural water quality variations and do not pose risks to human or animal health.

A longitudinal survey was conducted for Greens Canyon and its tributaries, Greens Hollow and Cowboy Creek. The extent of the longitudinal survey is shown on Figure 28. The survey shows Cowboy Creek being steeper in the headwaters and near the confluence with Greens Canyon, as the creek enters the Castlegate and Blackhawk formations. Greens Hollow has a relatively consistent slope until it enters the Blackhawk formation. The Greens Canyon stream channel is entirely in the Blackhawk formation, with a noticeable increase in the channel slope approximately 2,500 feet above the confluence with Muddy Creek.

A gain/loss study for Greens Canyon and its tributaries, Greens Hollow and Cowboy Creek, was conducted in September, 2001. These results are shown on Figure 29. The only Greens Hollow inflow noted was from Springs M_SP04, M_SP05, and M_SP06. The stream was flowing until the Castlegate Sandstone below M_STR6, where it was dry to the confluence with Greens Canyon. There was a loss of approximately 1.7 gpm where the stream flowed primarily over the Price River Formation and another loss of 1.9 gpm in the Castlegate Sandstone downstream of M_STR6.

Flow was noted in Cowboy Canyon until the middle of the Price River Formation. The Canyon was dry again until approximately 300 feet upstream of M_STR5, where water is coming from below a rock outcrop associated with the Blackhawk Formation. The stream loses and then gains water from M_STR5 to M_STR2 all along the Blackhawk Formation with flow disappearing below M_STR2. This study showed losses for both streams in the Blackhawk Formation and the Castlegate Sandstone. Greens Hollow did not flow in the Blackhawk Formation. Cowboy Creek and Greens Canyon had both gains and losses in the Blackhawk Formation. This was not unexpected given the variability in geologic conditions within these formations. Also, given the seasonal and year-to-year fluctuations in spring flows and associated ground water conditions within these formations, the results may not be representative of the gains and losses that may occur during other seasons or other years.

3.1.2.3 Unnamed Tributaries To Muddy Creek

Several small unnamed tributaries drain into Muddy Creek from the northern part of the Greens Hollow tract. A baseline monitoring station, M_STR7, has been maintained on the largest of these tributaries as shown in Figure 4. No flow was noted at this location during six monitoring visits between 9/25/02 and 5/13/04.

3.1.2.4 North Fork Quitchupah Creek

North Fork Quitchupah Creek flows into Quitchupah Creek, which eventually flows into Ivie Creek. Ivie Creek joins Muddy Creek about 10 miles south of the town of Emery. The average yield in North Fork Quitchupah Creek was estimated at 3.4 cfs (1,526 gallons/minute) by Thiros and Cordy (1991), using regional regression relationships. This report included a gain loss study of North Fork Quitchupah Creek, which showed an apparent gain in flow where the creek crossed the Castlegate Sandstone, a loss of flow as it crossed the upper part of the Blackhawk Formation, a slight gain in flow crossing the lower Blackhawk Formation, a considerable gain in flow crossing Star Point Sandstone and a loss in flow crossing the Mancos Shale.

The North Fork Quitchupah Creek is a perennial stream. SUFCO Station 006 (M_STR9) monitors the South Fork of North Fork Quitchupah Creek and Station 007 (M_STR10) monitors the upper segments of North Fork Quitchupah Creek. These stations are located near the confluence of these streams, just before the deep canyon that forms downstream of the Castlegate Sandstone outcrop. A summary of water quality parameters is shown on Tables 6, 15, and 16 and Figures 30 and 31. Most of the parameters for these stations were analyzed on a totals basis while many of the standards are for dissolved constituents. M_STR9 had occasional violations of the temperature standard and exceeds the pollution indicator value for total phosphorous of 0.05 mg/l over half the time with a maximum reported concentration of 1.12 mg/l. The highest concentrations of total phosphorus were typically measured in the spring season. Concentrations of total phosphorus during other times of the year were slightly above or below 0.05 mg/l. M_STR10 had one violation of the pH standard and occasional violations of the temperature standard. The water at this station exceeds the pollution indicator value for total phosphorous of 0.05 mg/l over half the time with a maximum reported concentration of 1.64 mg/l. Peak concentrations of total phosphorus were observed during the spring season as well as the fall season.

As mentioned above in Section 3.1.2.2, total phosphorous concentrations come from both natural and anthropogenic sources. The relative amounts contributed by each source can vary by location, season, year, wildlife population dynamics and livestock management practices employed in the analysis area. The seasonal peaks observed during monitoring at these two sites are typical of patterns associated with surface runoff from snowmelt or intense storm events. Peaks during the fall season are less common but could also be influenced by decaying organic matter, direct manure deposition, and low base flows. Although total phosphorus concentrations do exceed the 0.05 mg/l pollution indicator value, Utah DWQ monitoring has not identified problems due to high phosphorus in downstream segments of North Fork Quitchupah Creek. At the present time, the upper segment of Quitchupah Creek is not supporting the beneficial use for cold water aquatic life due to poor condition of benthic macroinvertebrates, as indicated in the 2010 303(d) list of impaired waters for Utah (Utah DWQ 2012). The upper segment extends from State Highway 10 to the headwaters and includes North and South Fork Quitchupah Creek. The pollutant sources leading to this condition are currently unknown and the priority to develop a TMDL and identify each source is low.

South Fork joins North Fork Quitchupah Creek from the west near the analysis area boundary as shown on Figure 1. Dry Fork enters the North Fork Quitchupah Canyon further downstream and SUFCO Station 042 monitors the North Fork just above its confluence with Quitchupah Creek.

Since 1982, SUFCO Mine discharges have increased base flows in North Fork Quitchupah Creek. Before September 1982, mine water was discharged into East Spring Canyon. Since 1983, Canyon Fuel has been discharging excess intercepted ground water from their underground workings, via a UPDES discharge point, into North Fork Quitchupah Creek. This discharge averaged approximately 1,000 gpm during the period of 1983 through 1994 (Mayo and Associates 1999). Between 1994 and 1996, discharge averaged approximately 1,500 gpm (Mayo and Associates 1997b). Discharge rates tend to relate to coal production rates and are not seasonally affected (DOGM 2005).

Mayo and Associates (1997b) studied the current and past influence of the mine water discharge on Quitchupah Creek. They note that flow in North Fork Quitchupah Creek above the mine discharge point averages about 2,650 gpm in spring (5.9 cfs) and about 290 gpm (0.6 cfs) in low, base flow conditions in late fall. The average increase in flow due to mine discharge is therefore substantial, about 37 percent in spring and 337 percent in fall. The source of the additional water is from the Blackhawk Formation zones immediately above coal seams. This water is deeper ground water and otherwise disconnected from shallow ground water zones that naturally support stream flows in the channel. Adverse impacts on Quitchupah Creek's stream morphology and/or stability due to 15 years of increased flows were not noted in this report. In the Cumulative Hydrologic Impact Assessment of the SUFCO Mine, DOGM (2003a) states that "no adverse impacts have been identified from discharging mine water". However, no information on channel characteristics or monitoring of channel changes was included in either of these reports.

3.1.2.5 Floodplains

Below its confluence with lower Box Canyon Creek, Muddy Creek Canyon becomes somewhat wider (averaging about 300 feet) and the channel's sinuosity increases. However, the channel is still entrenched, and is confined within a narrow valley bottom. As discussed previously in Section 3.1.2.1, a small floodplain occurs in this reach of Muddy Creek, immediately below the confluence with Box Canyon. Muddy Creek's gradient, as measured from the USGS 7.5-minute topography, averages about 3 percent in this area.

The estimated 100-year peak flow on Muddy Creek at the confluence with Box Canyon is 3,423 cfs. Flows of this magnitude would inundate most of the 300-foot bottom of the valley.

The North Fork Quitchupah Creek downstream of the Greens Hollow tract flows in a narrow, deep canyon with steep cliffs formed by the Castlegate Sandstone and bedrock channel conditions. Below its confluence with Quitchupah Creek, the valley bottom becomes wider with low terraces of limited extent. The channel is incised such that there is no broad flood plain.

3.1.2.6 Ponds

A total of 19 ponds were identified in or adjacent to the analysis area including 11 natural ponds and eight stock ponds. Natural ponds are formed in depressions that occur at topographic breaks in slope (e.g. benches, slumps, etc) or in low lying areas of drainages. Natural ponds are filled through a combination of surface runoff from snowmelt and high intensity precipitation events as well as shallow ground water discharge. The presence of water in natural ponds throughout the summer is more likely influenced by the rate of ground water discharge than the ability to capture surface runoff. Overstory vegetation that surrounds natural ponds can also provide shade and reduce evaporation levels. Natural ponds are utilized by livestock and wildlife as a water source. Although water levels in natural ponds were noted to decrease during the summer, few natural ponds dried up entirely.

Stock ponds are designed and constructed by humans. All stock ponds are fed by surface runoff occurring from snowmelt and high intensity precipitation events. A total of nine cattle troughs were also identified in the analysis area. The location of stock ponds, natural ponds, and cattle troughs are shown on Figure 32. Quarterly field visits to five stock ponds in the Muddy Creek Tract boundary from summer 2002 through fall 2003 (including several in the Greens Hollow tract) indicated that most stock ponds were dry by the early summer season. All monitoring data collected from stock ponds is contained in Cirrus (2004b).

3.1.2.7 Surface Water Summary

All of the surface water in the Greens Hollow tract drains into either the North Fork Quitchupah Creek or Muddy Creek. Field monitoring of tributary stream channels during 2001-2004 indicated that little perennial surface flow from the Greens Hollow tract reached Muddy Creek. Seasonal flow was observed at station STR1 during the spring of two monitored years including 2003 and 2004. No flow was observed at this station later than the end of June during any year of monitoring. No flow was observed at station STR7 during quarterly monitoring visits which were generally made in June, August, and October. Perennial surface flow in North Fork

Quitchupah Creek, which crosses the Greens Hollow tract, does reach Quitchupah Creek. As mentioned above in Section 2.4.4, flow monitoring data was collected during below average water years. This conclusion is based on more than 30 years of record at stations on Muddy Creek and nearby SNOTEL stations (USGS 2013, USDA-NRCS 2013).

Nineteen ponds and nine cattle troughs are located in or immediately adjacent to the Greens Hollow tract boundary. Field observations indicated that inflows to stock ponds are characterized by surface runoff occurring from snowmelt and high intensity precipitation events.

3.1.3 WATER RIGHTS

Water on National Forest System lands is used consumptively for livestock and wildlife watering. Some, but not all, springs have been developed. Forest Service claims for water rights were prepared in the 1980's as part of a general adjudication process. It appears that there was direction at the time of the filings to emphasize point to point claims on streams. Since that time, the Forest Service has continued to work with the Utah DWRi to develop an efficient and comprehensive method for documenting and claiming water uses on lands administered by the Forest Service. To that end, subbasin claims are being developed that would assert a claim of right for all developed and undeveloped waters on National Forest System lands. Therefore, all developed and undeveloped springs in the permit modification area should be assumed to have a claim of right associated with them, irrespective of whether there is a specific filing in the Division of Water Rights database.

There are no registered water rights for water production wells used for municipal, domestic, or irrigation purposes in the analysis area. Points of diversion were obtained from the Utah DWRi. A complete listing of all water rights in the analysis area and their associated water features is provided in Cirrus (2004b) and Cirrus (2014).

Spring M_SP01 is located adjacent to Rough Brothers of the Hills cabin, on the south side of Greens Hollow. The water right number associated with this spring is 94-472, as shown on the Heliotrope Mountain hydrographic survey map. The water use for water right 94-472 described in the Utah DWRi database is stock watering. The owner of this water right is listed as the USFS. As mentioned above in Section 3.1.1.3, this spring has been developed with a spring box and pipeline system and is currently used for culinary water and irrigation use.

All points of diversion in the analysis area are shown in Figure 33, with each symbol potentially representing multiple water rights. A total of 70 water rights that are approved or perfected were identified (Cirrus 2014). The majority of these rights (65) belong to the USFS for stock watering along streams and from springs. Canyon Fuel Company holds 5 water rights that are approved or perfected in the analysis area. Water is used by Canyon Fuel Company for temporary water mitigation and exploratory drilling incident to coal mining.

A search of all water rights associated with Muddy Creek down to the confluence with the Dirty Devil River indicated that water is primarily used for irrigation purposes. The Utah Division of Water Resources has identified a total of 17,000 ac-ft/yr that are diverted from Muddy Creek for irrigation purposes (Utah DWRe 2001). Use of culinary water is described below in Section 3.3.2.5. Industrial use of water from Muddy Creek is limited to temporary (short-term) use by construction and privately owned mining operations. These water rights are generally limited to less than 2 ac-ft/yr. Applications for large water rights (>1,000 ac-ft/yr) have been submitted in the past by Utah Power and Light and Consolidation Coal Company. These applications were denied.

3.1.4 Drinking Water Source Areas

Drinking water source protection zones are designated areas surrounding a well, spring, tunnel or surface water body through which pollution could move and eventually contaminate a water source (Utah DDW 2005, Utah DDW 2012). These areas are typically divided into zones that define the time of travel to the intake structure. Analysis of drinking water source protection zones was restricted to only those zones that intercepted the analysis area. A general description of the protection zones that were found in the analysis area includes the following (Utah DDW 2005):

Zone 1:

Surface Water: One-half mile from the high water mark of each side of the stream channel and from 100 feet below intake up to 15 miles above intake.

Zone 2:

Surface Water: Begins at the end of zone one and extends up to 50 miles upstream, 1000 feet from each side of stream channel (bank-full).

Zone 3:

Surface Water: Begins at the end of zone two and extends up to watershed boundary and 500 feet on each side measured from high water mark of the source. Note: The Utah DDW has not defined this zone for surface water bodies in the analysis area.

Zone 4:

Surface Water: All of the watershed contributions to the source that is not part of zones one through three.

No regulatory overtones are established for each of these zones (Jensen 2004, Jensen 2013). However, it should be noted that a greater potential exists for contamination of drinking water from activities in the lower number zones.

Three surface water protection zones were identified in the analysis area for a diversion from Muddy Creek, near the town of Emery (Figure 34). Water from Muddy Creek is initially diverted into a canal at a point immediately below a USGS stream gage (Station 09330500) located near the mouth of Muddy Creek Canyon. Water is then diverted from the canal at a site located approximately 2,000 feet north of the town. Information from the Utah DDW indicates this diversion is capable of supplying 250 gpm and serves a population of 293 individuals. All domestic water used from this source is fully treated before entering the culinary water system. Culinary water is supplied to Emery and other nearby towns by the Castle Valley Special Service District. Per capita use of culinary water for the District has been calculated at 191 gallons/day (Utah DWRe 2001). Based on the population numbers above, the annual culinary water use for Emery is approximately 63 acre-ft per year. The surface water protection zones associated with this diversion are included in Figure 34 and extend upstream from the diversion point to include the upper portion of the Muddy Creek watershed.

5.0 LIST OF PREPARERS WITH QUALIFICATIONS OF PREPARERS

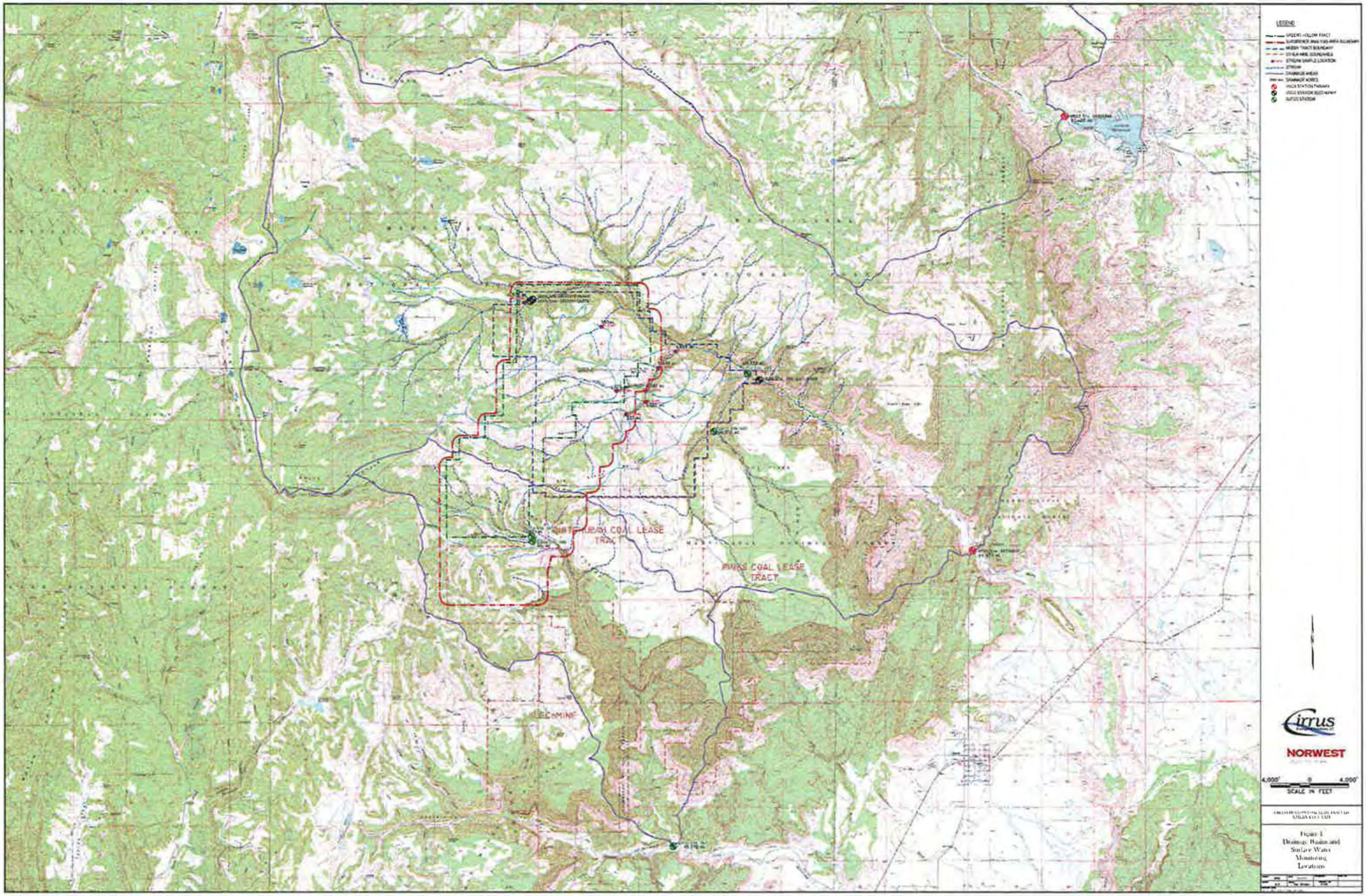
Eric K. Duffin MS, Watershed Scientist/Hydrologist, Cirrus Ecological Solutions. Mr. Duffin has 17 years of experience in watershed science including hydrology, water quality, soil physics, fluvial geomorphology, and computer science. His graduate and post-graduate work examined snowmelt runoff, soil erosion, infiltration, evapotranspiration, and unsaturated soil moisture flow in sagebrush-steppe ecosystems. His experience includes evaluation and analysis of proposed watershed improvements, conducting hydrologic inventories, quantifying point and non-point source pollution, computer modeling, stream surveying, water quality sampling, datalogger programming and remote data retrieval. He has managed TMDL projects, served on several NEPA project teams, and provided technical writing and editing for other physical and human-resource disciplines.

Arthur O'Hayre, Ph.D. Dr O'Hayre has over 30 years of professional experience as a hydrologist, including 24 years working with the coal mining industry working on hydrologic characterization, operational planning, and environmental permitting and compliance. He has participated in the preparation of baseline surface and ground water information and development of the probable hydrologic consequences (PHC) analyses for a number underground coal mining operations, including San Juan Coal Company's Deep Mine in New Mexico, Twentymile Coal Company's Foidel Creek Mine in Colorado, Mountain Coal Company's Mt. Gunnison No. 1 Mine in Colorado, and Meridian Coal Company's Bull Mountains No. 1 Mine in Montana. Dr. O'Hayre also managed the hydrologic analyses and related permit application submittals for BHP's Alton Coal Project and ARCO's Huntington Canyon No. 4 Mine in Utah. He also developed the surface water control and reclamation plans for these projects.

Seth Okeson. Mr. Okeson is a water resources engineer with 12 years of varied consulting experience with specialization in hydrologic modeling. He is experienced in data collection, management, and interpretation. Modeling projects include coal-bed methane impact assessment, transport from mill tailings, ground water flow at a landfill, and integrated surface water ground water modeling. He worked on the calibration and application of the ground water model used for impact analysis of proposed CBM development for the Wyoming Powder River Basin Oil and Gas EIS. He also worked on developing the ground water model used to evaluate produced water production volumes and the potential effects of withdrawal of water on the shallow aquifer and springs for a prospective CBM project in Australia. He also worked on the salt loading model used to evaluate various water management strategies for this project.

APPENDICES:

FIGURES



LEGEND
GREENS HOLLOW TRACT
STREAM SAMPLE LOCATION
STREAM
DRAINAGE AREAS
USGS STATION PRIMARY
PINES COAL LEASE TRACT
COAL LEASE TRACT
NORWEST
4,000' 0 4,000'
SCALE IN FEET
Drainage Basins and
Surface Water
Monitoring
Locations

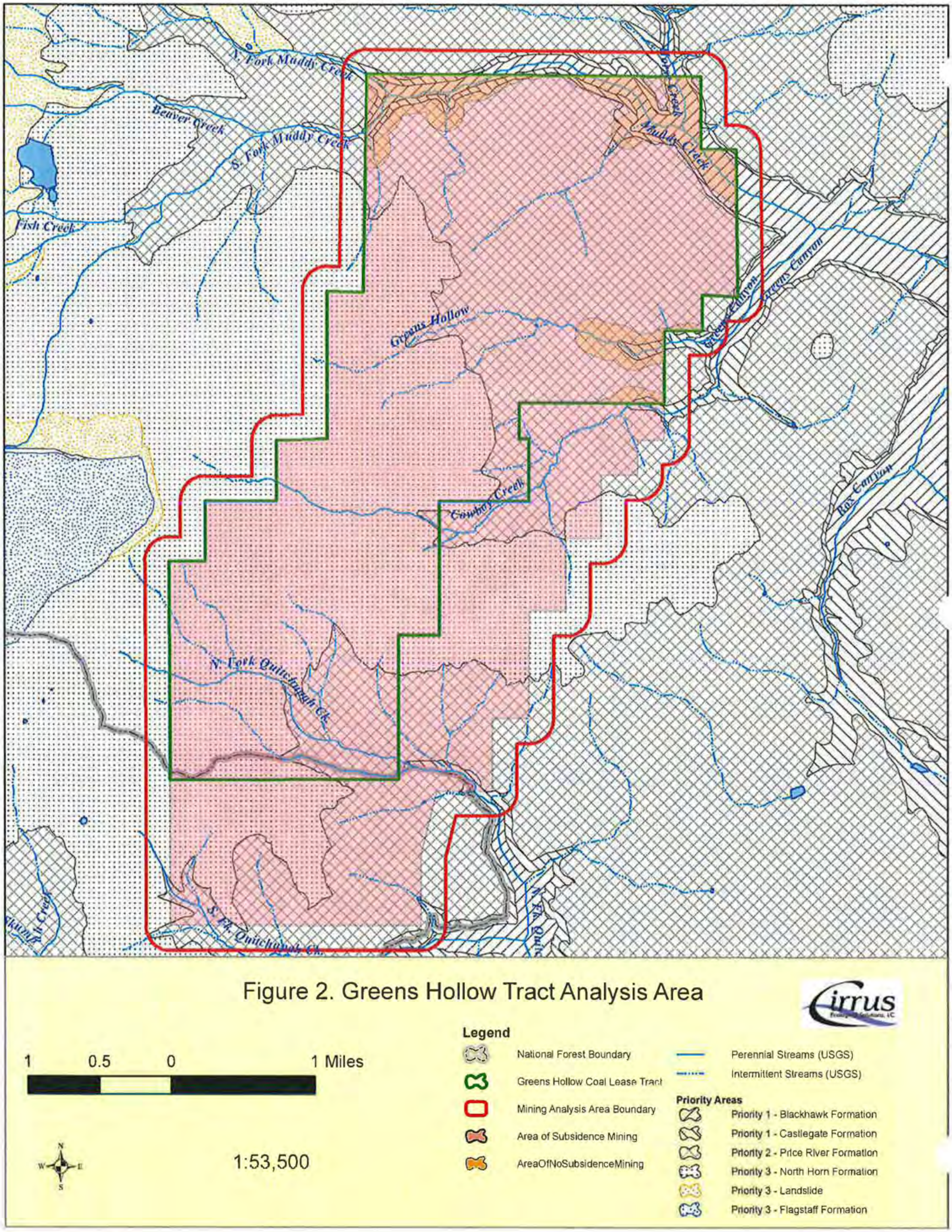
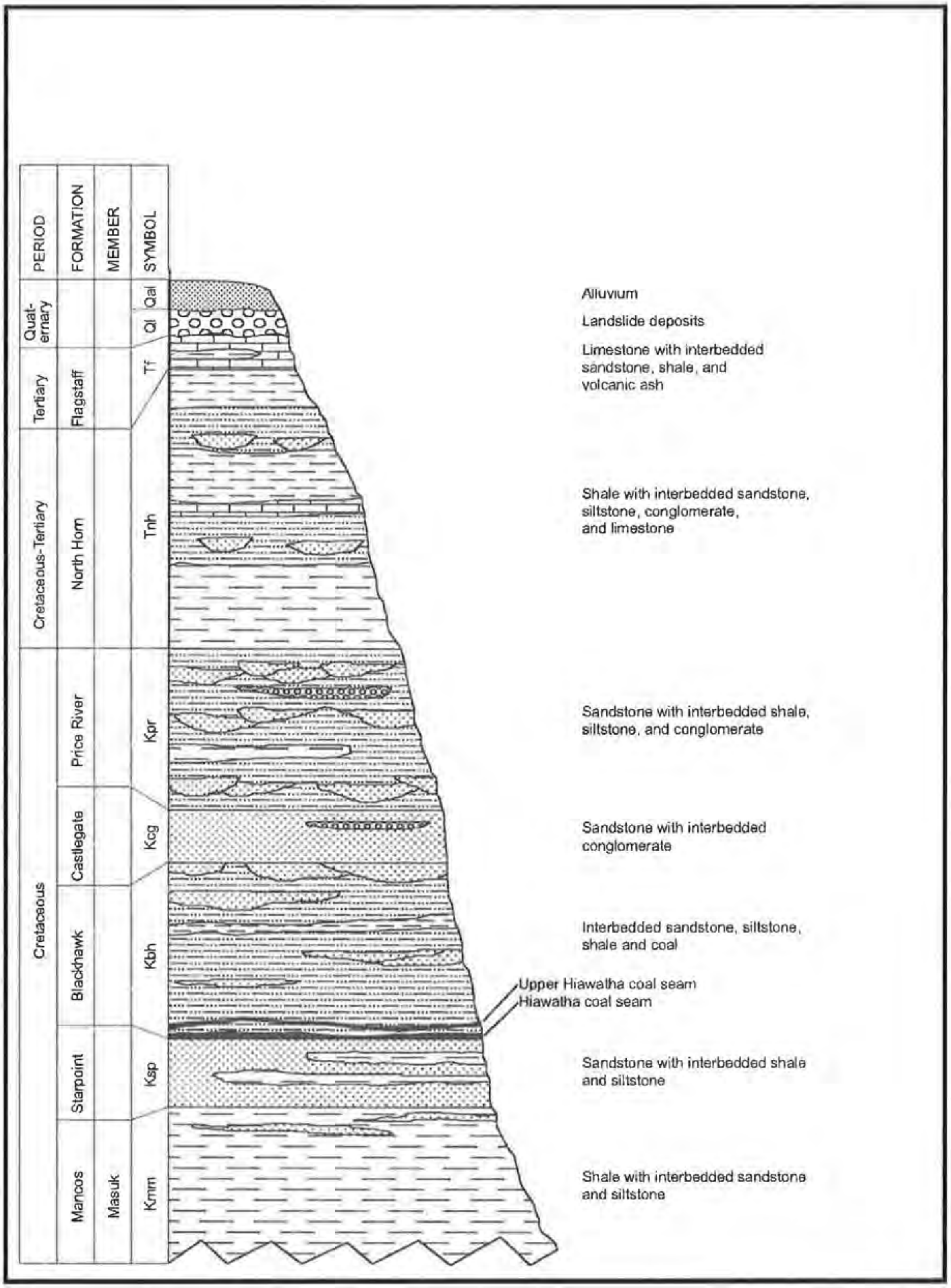


Figure 2. Greens Hollow Tract Analysis Area

Figure 3. Generalized Stratigraphy of the Greens Hollow tract (Anderson 2004).



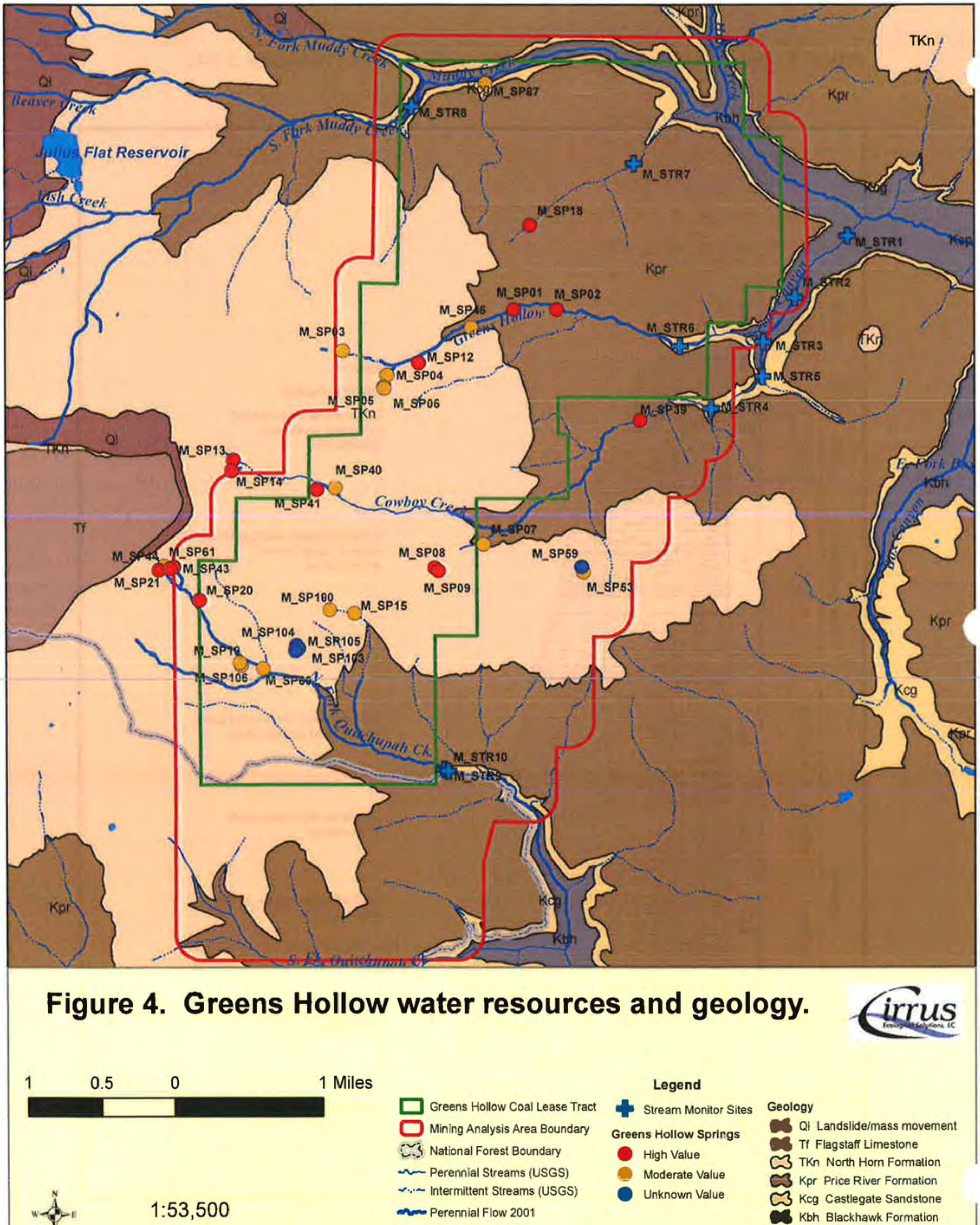


Figure 4. Greens Hollow water resources and geology.

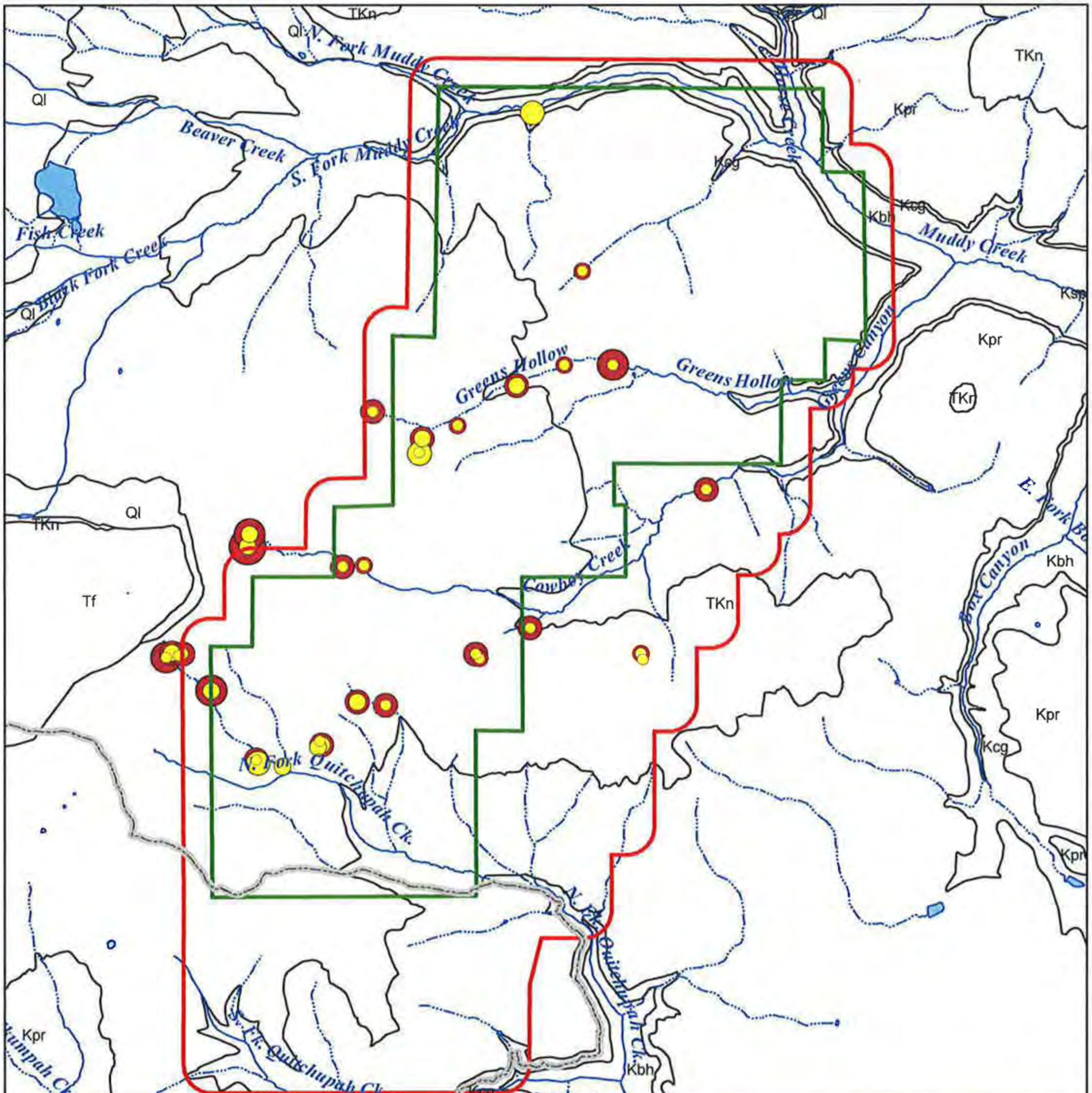


Figure 5. Flow Range for Measurable Springs

Cirrus Ecological Solutions, LC

1 0.5 0 1 Miles

1:53,500

N W E S

Legend

- Greens Hollow Coal Lease Tract
- Mining Analysis Area Boundary
- National Forest Boundary
- Perennial Streams (USGS)
- Intermittent Streams (USGS)

Min. Flow (gpm)	Max. Flow (gpm)
0 - 0.5	0 - 0.5
0.5 - 1	0.5 - 1
1 - 5	1 - 5
5 - 20	5 - 20
20 - 65	20 - 65

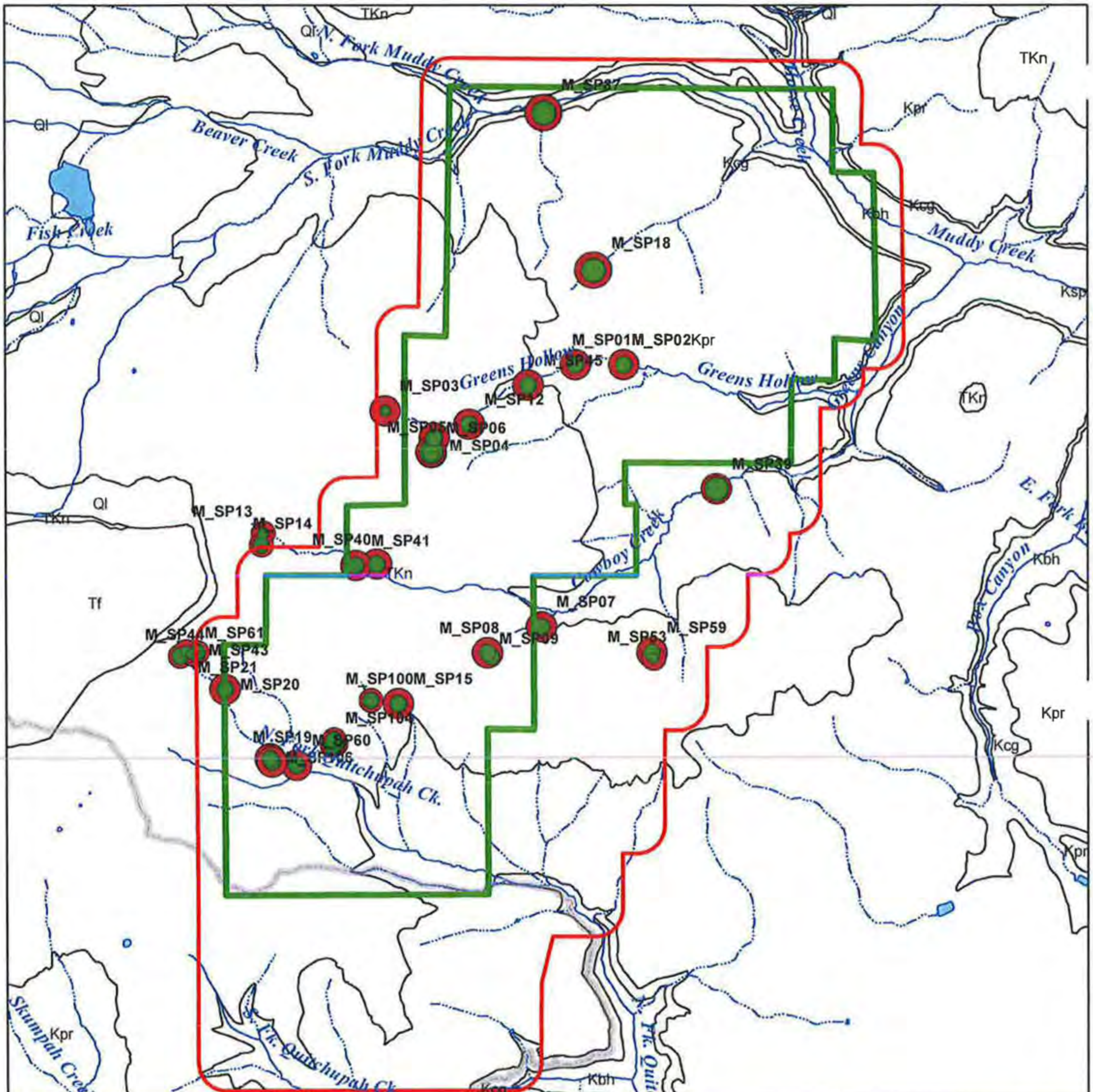


Figure 6. Specific Conductance Range for Measurable Springs

1 0.5 0 1 Miles

1:53,500

GEOLOGY SYMBOLS
Ql Landslide Mass movement
Tf Flagstaff Limestone
Tkn North Horn Formation
Kpr Price River Formation
Kcg Castlegate Sandstone
Kbh Blackhawk Formation

Legend

Greens Hollow Coal Lease Tract
Mining Analysis Area Boundary
National Forest Boundary
Perennial Streams (USGS)
Intermittent Streams (USGS)

Min. Spec. Cond. (mmhos/cm)	Max. Spec. Cond. (mmhos/cm)
0-250	0-250
250-500	250-500
500-750	500-750
750-1100	750-1100
1100-1500	1100-1500

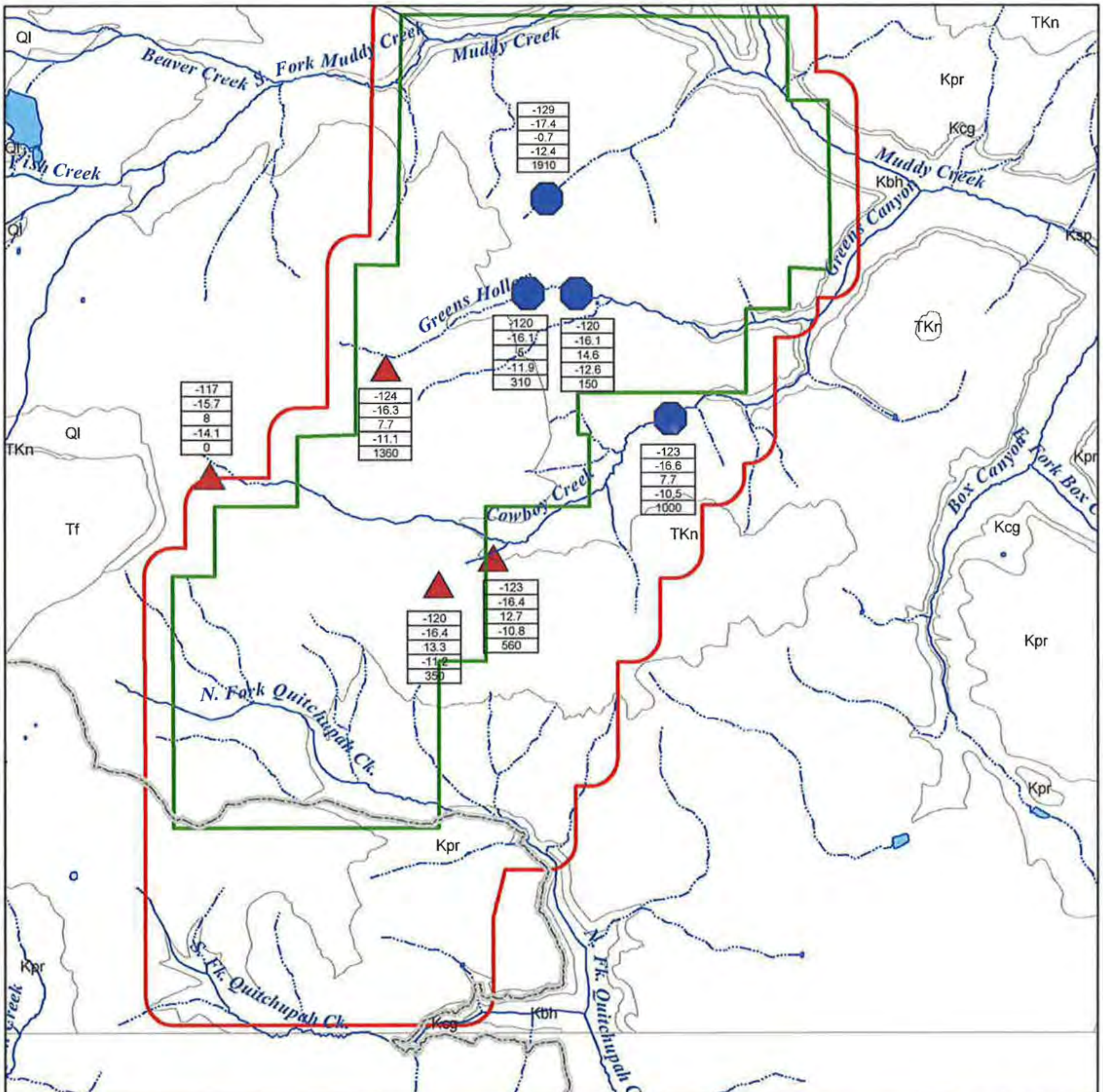


Figure 7. Spring Water Isotope Sampling

Cirrus Ecological Solutions, LC

1 0.5 0 1 Miles

1:53,500

GEOLOGY SYMBOLS
Qal - Alluvium
Ql - Landslide/Mass movement
Tf - Flagstaff Limestone
Tkn - North Horn Formation
Kpr - Price River Formation
Kcg - Castlegate Sandstone
Kbh - Blackhawk Formation
Ksp - Starpoint Sandstone
Kms - Mancos Shale

N W E S

Legend

Greens Hollow Coal Lease Tract

Mining Analysis Area Boundary

National Forest Boundary

Isotope Measurements

Deuterium (^2H)	-120	Per Mil
^{18}O	-16.1	Per Mil
Tritium (^3H)	5	Tritium Units
^{13}C	-11.9	Per Mil
^{14}C	310	Year-Unadjusted

Perennial Streams (USGS)

Intermittent Streams (USGS)

Isotope Sampling - Springs

North Horn Formation

Price River Formation

Figure 8. Greens Hollow Tract Springs Unstable Isotope Results

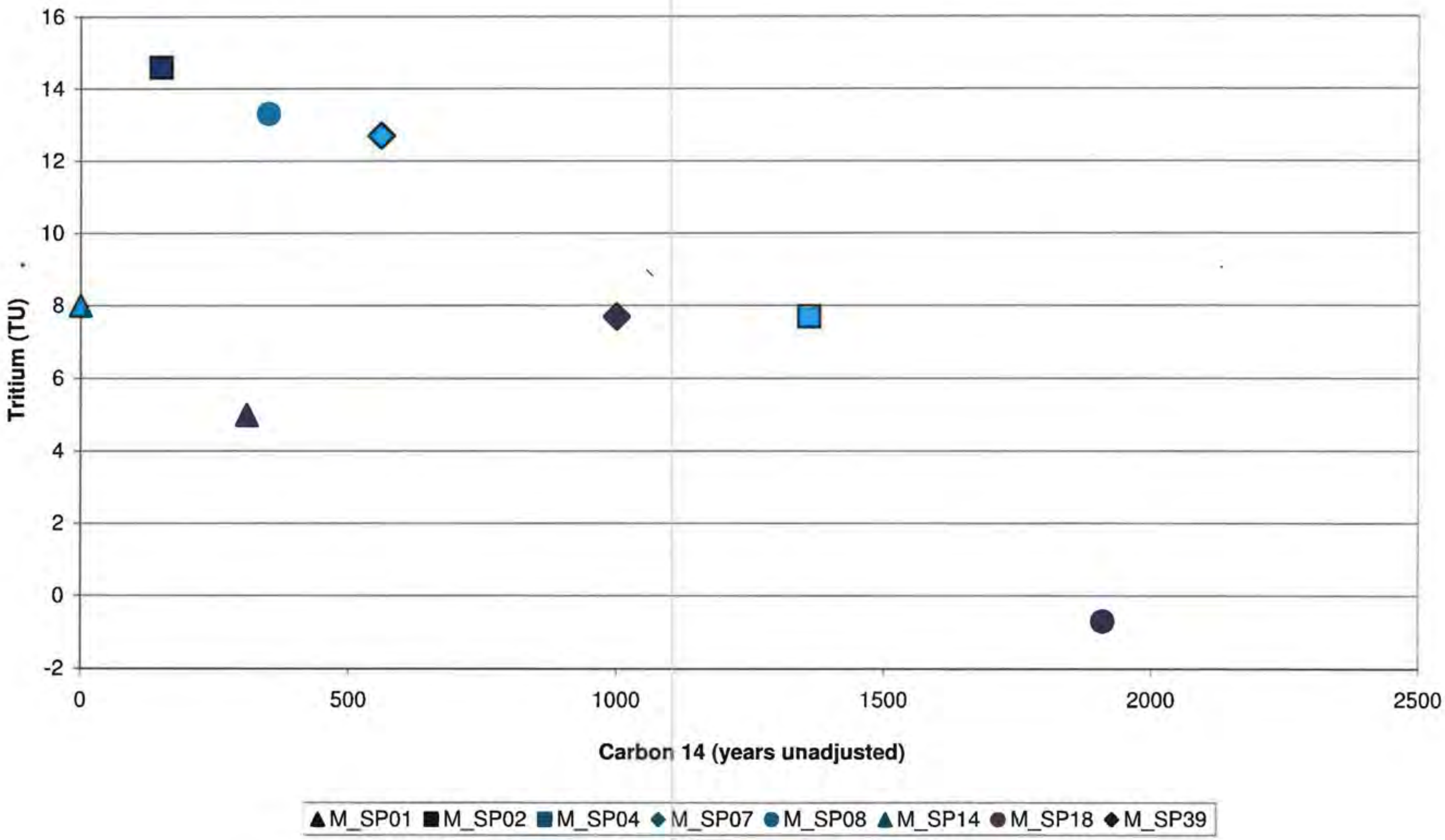


Figure 9. Greens Hollow Tract Springs Stable Isotope Results

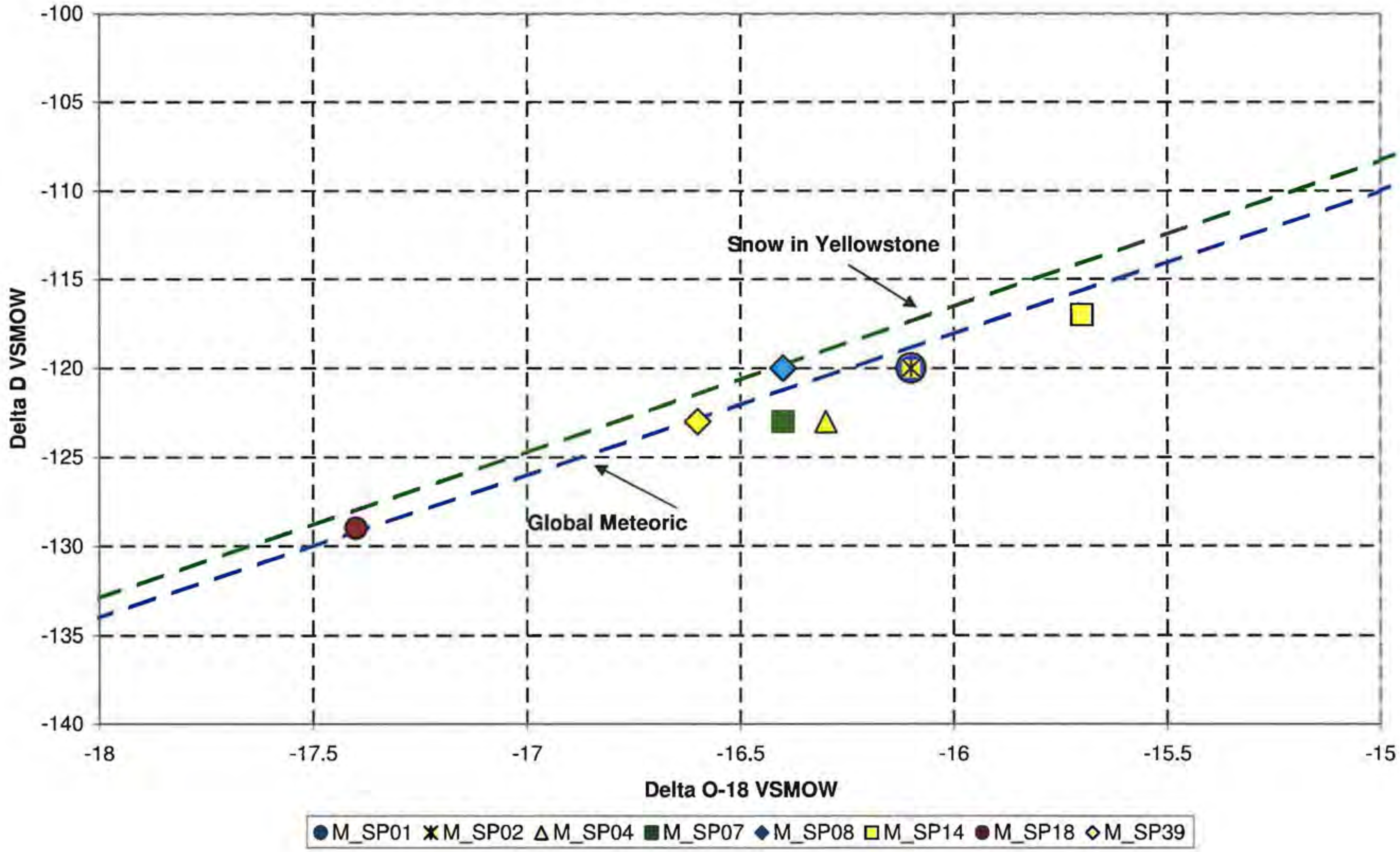


Figure 10. North Horn Formation Spring M_SP04

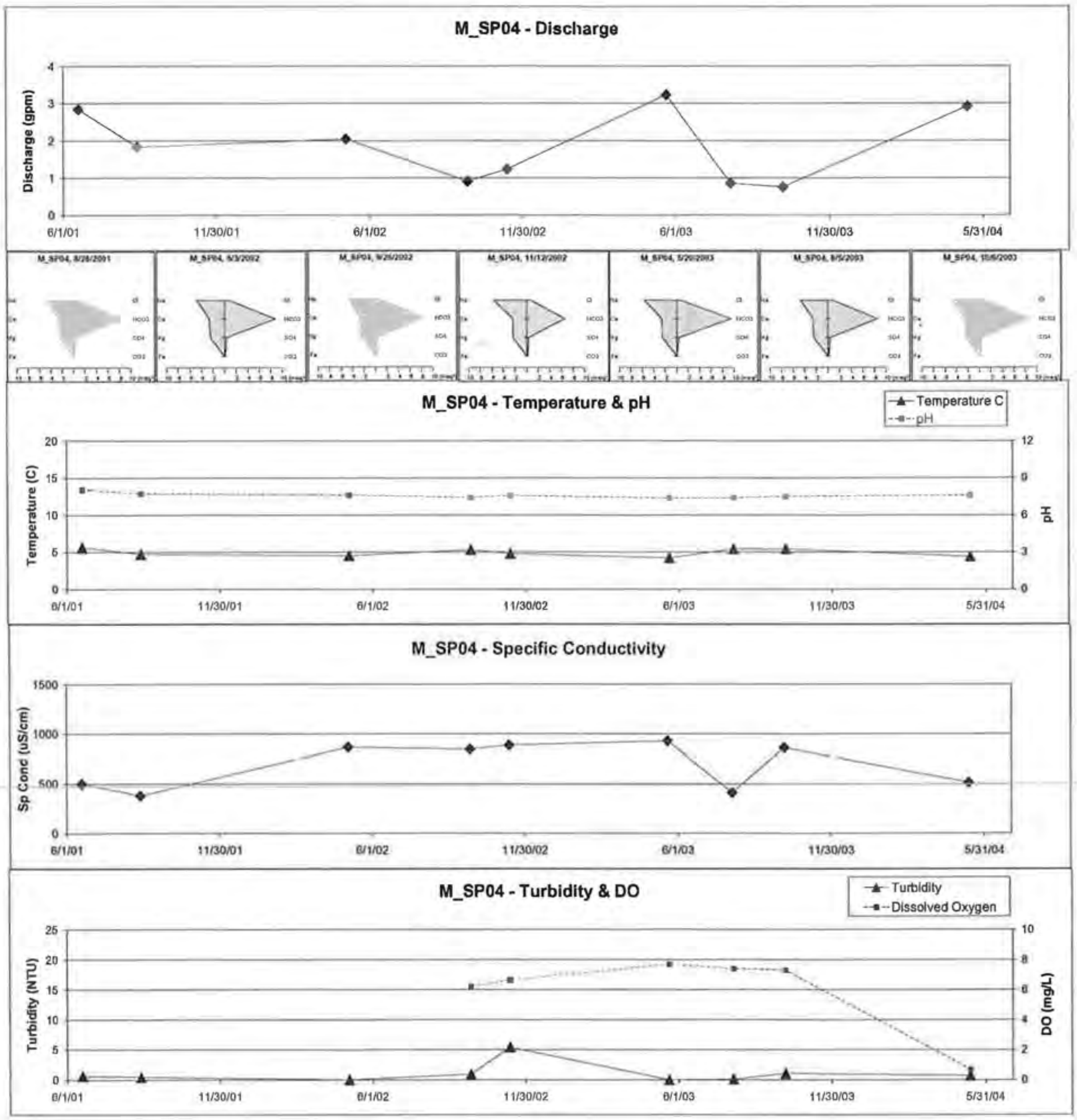


Figure 11. North Horn Formation Spring M_SP07

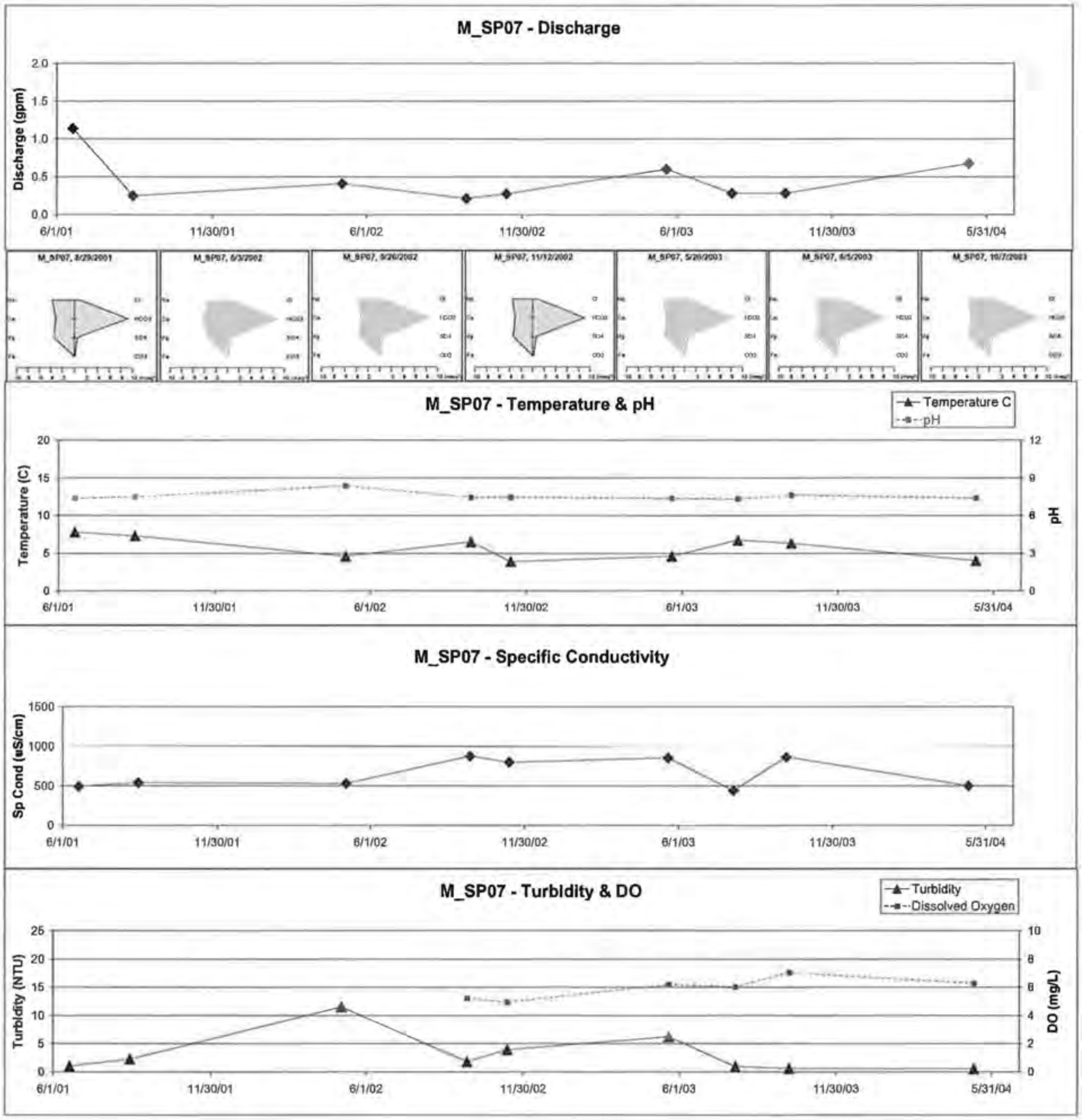


Figure 12. North Horn Formation Spring M_SP08

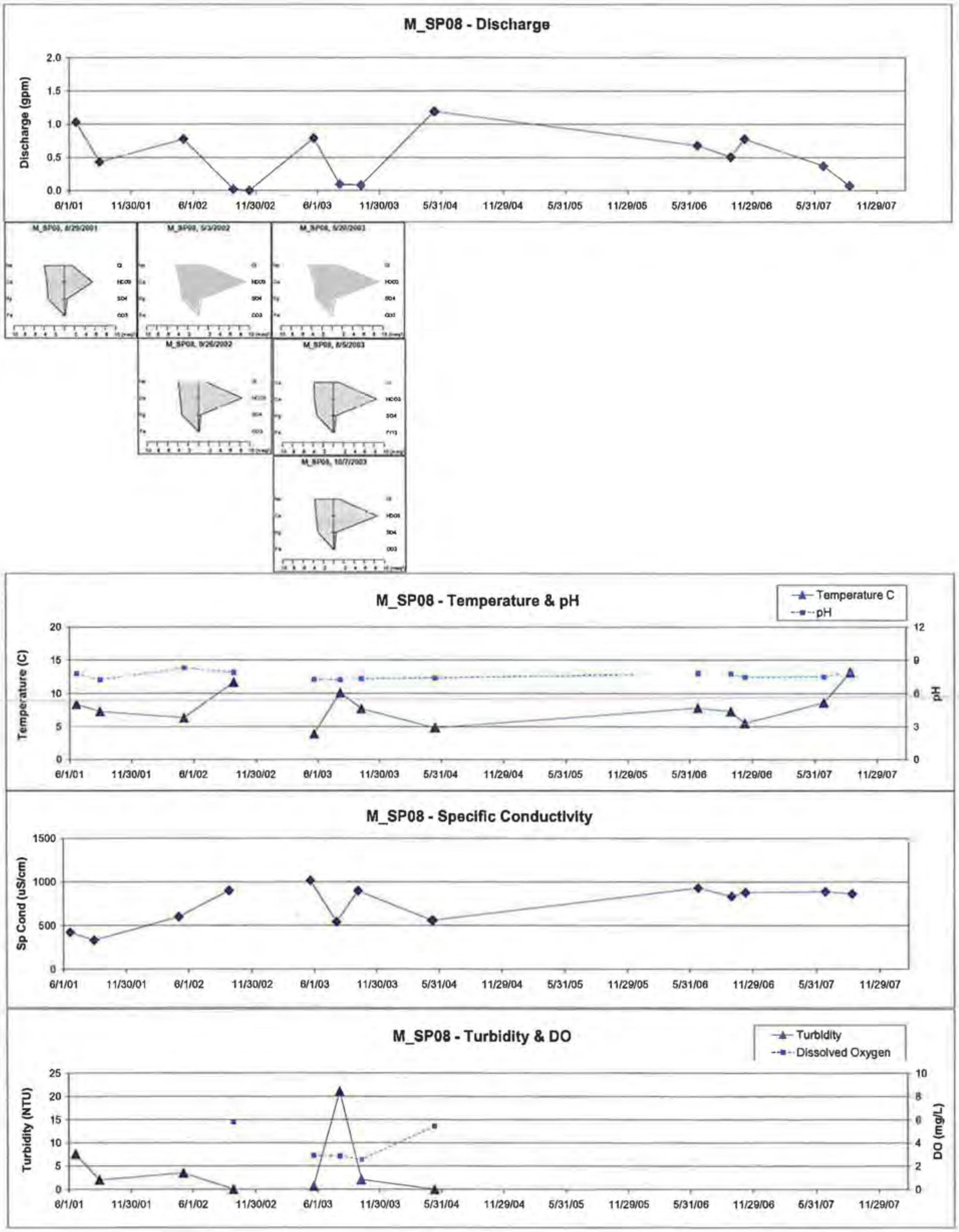


Figure 13. North Horn Formation Spring M_SP14

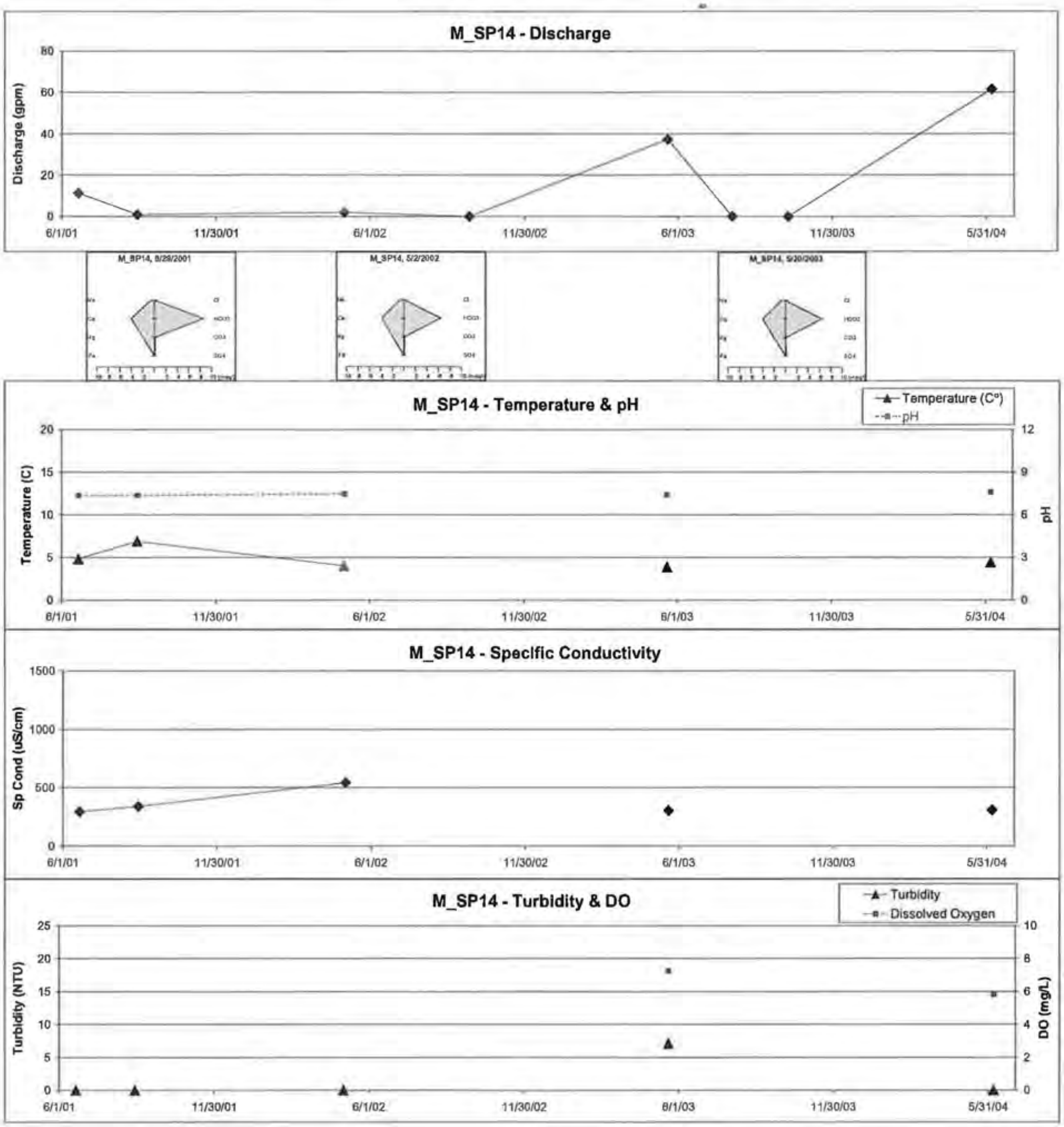


Figure 14. Price River Formation Spring M_SP01

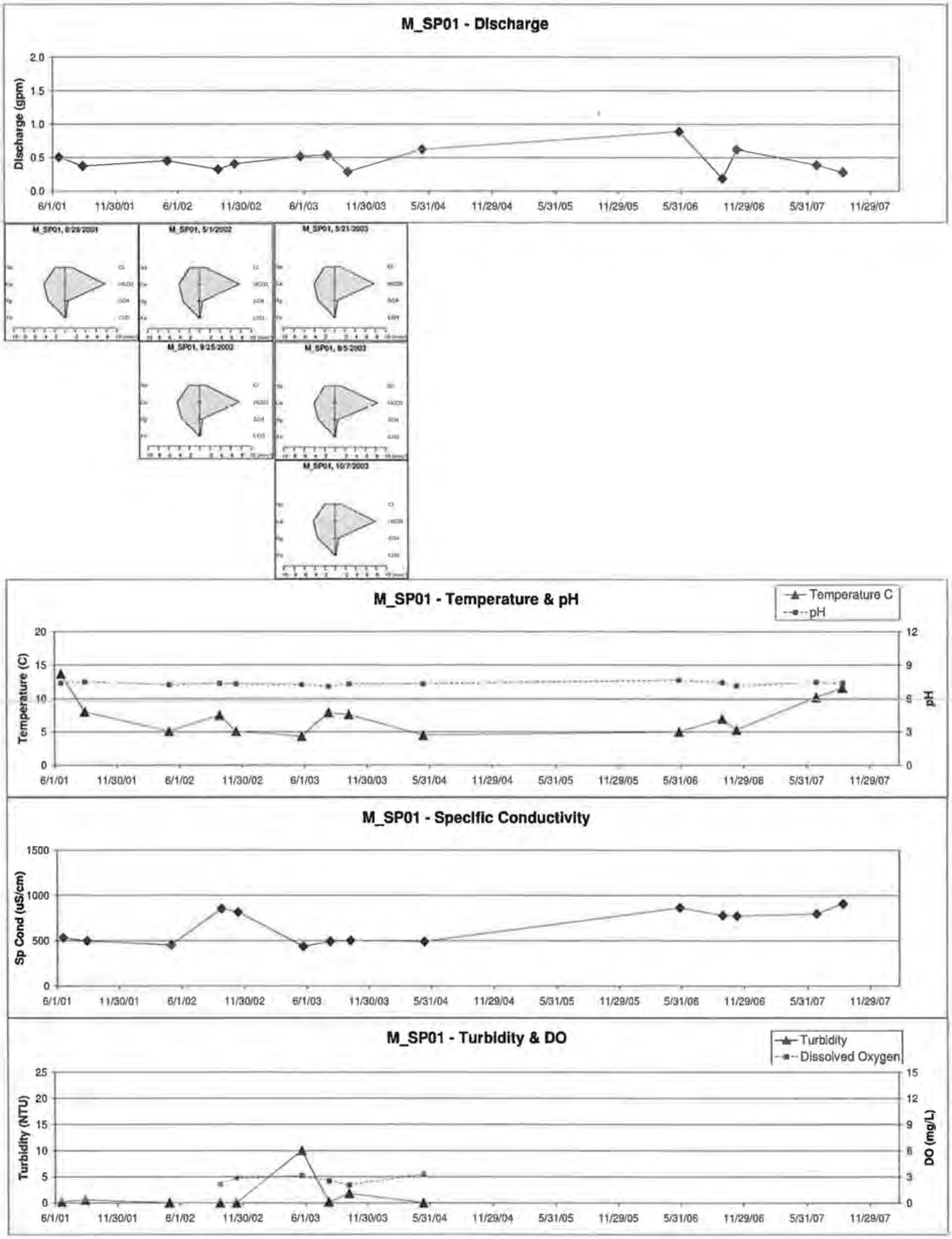


Figure 15. Price River Formation Spring M_SP02

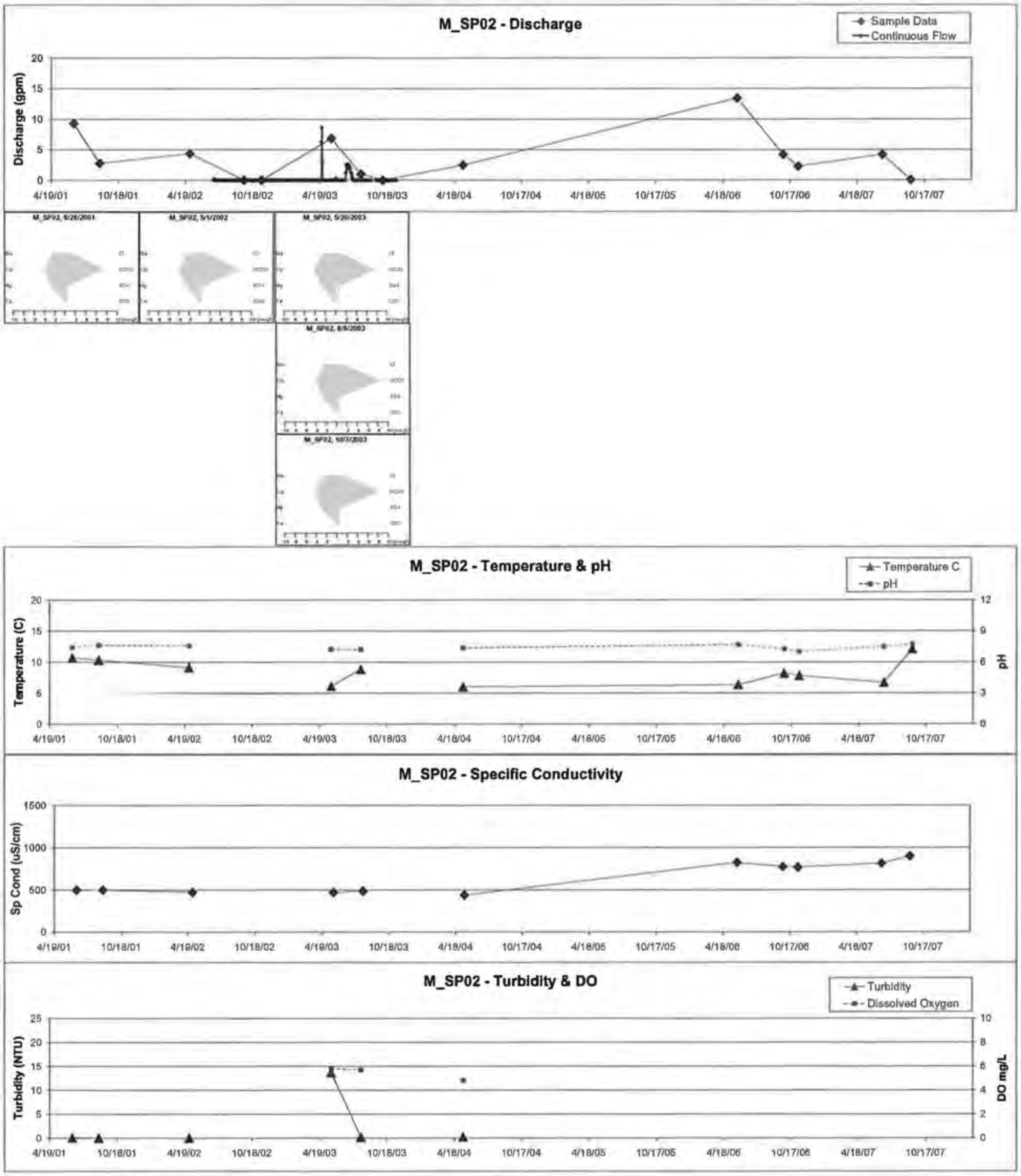


Figure 16. Price River Formation Spring M_SP18

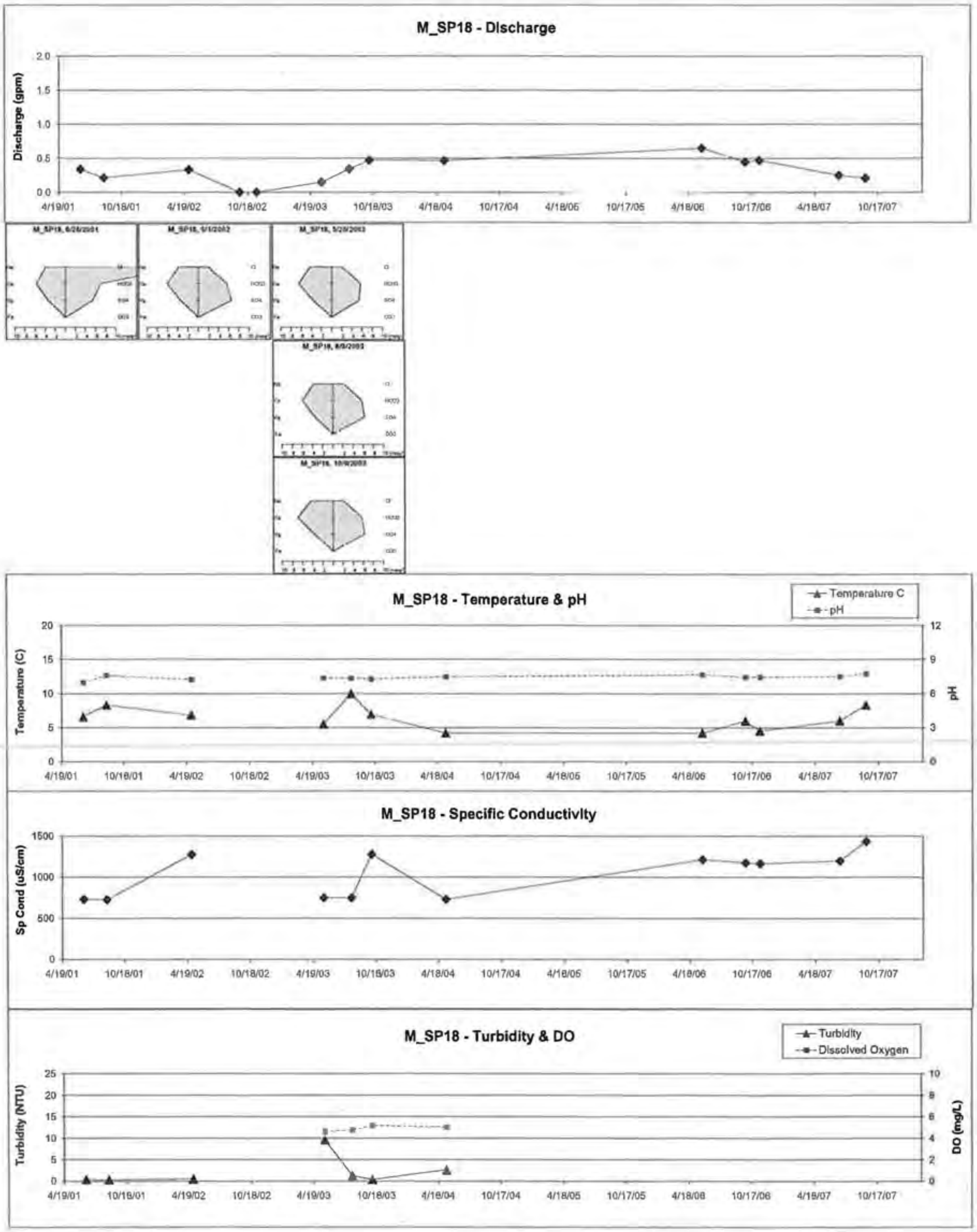
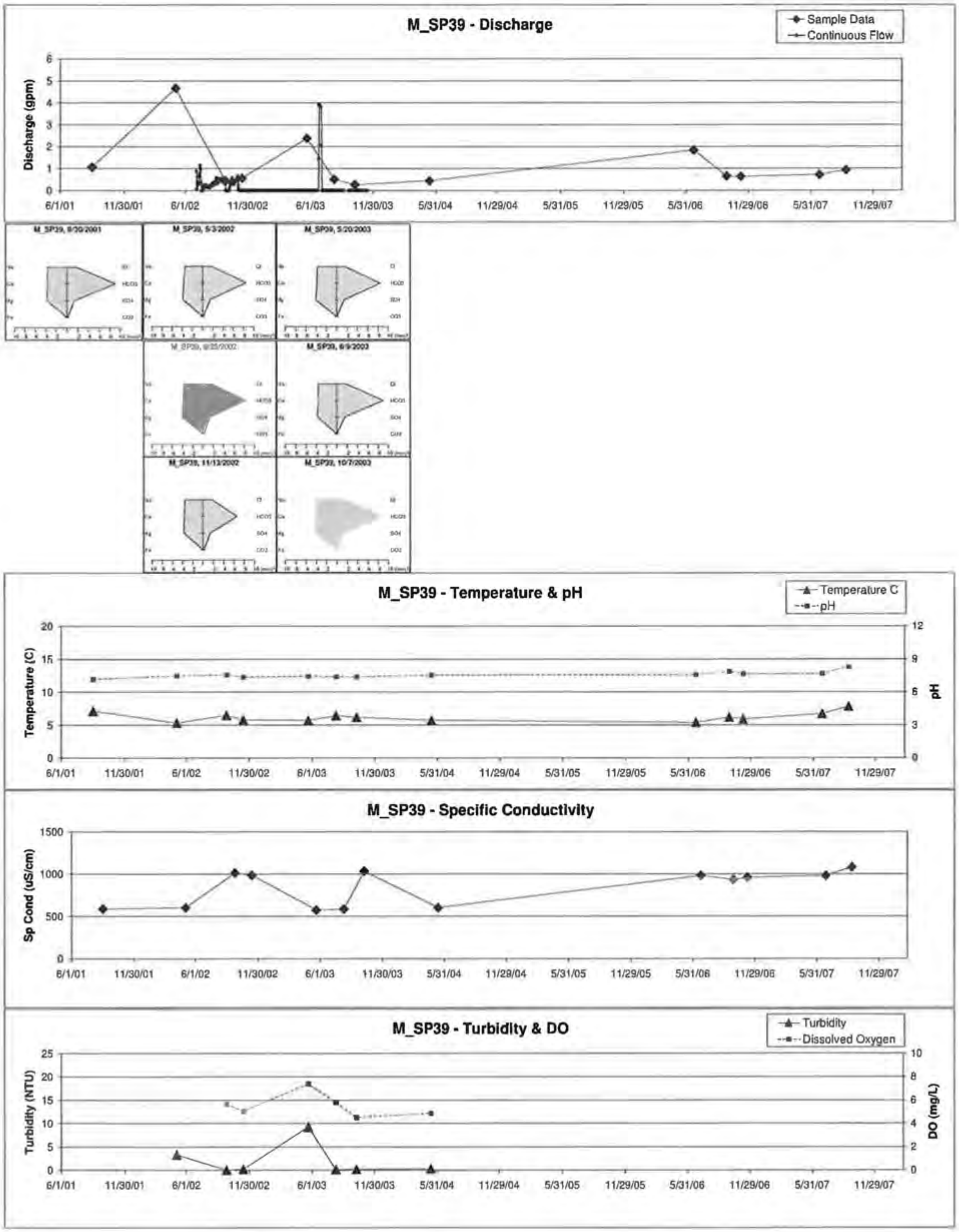


Figure 17. Price River Formation Spring M_SP39



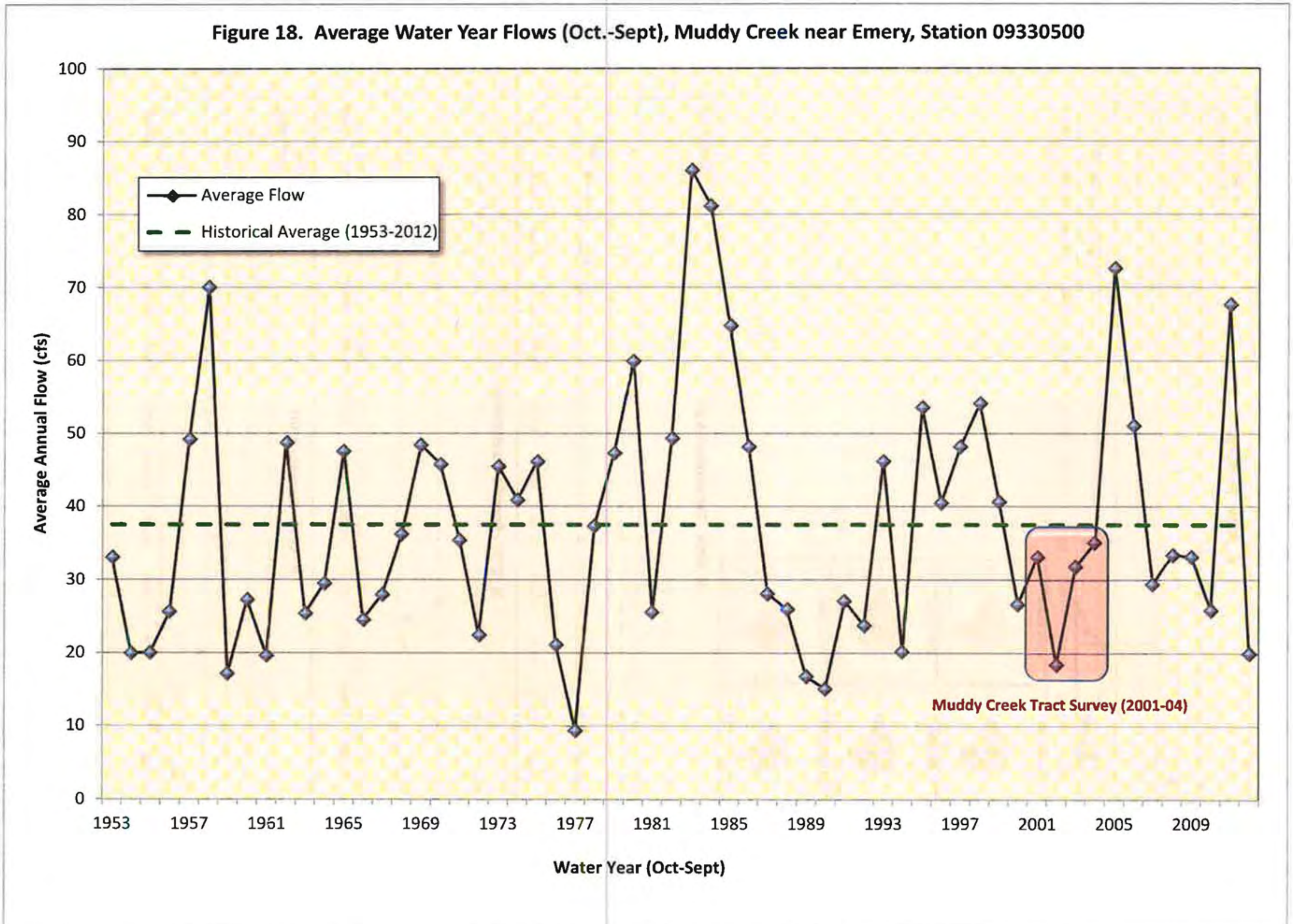


Figure 18. Average Water Year Flows (Oct.-Sept), Muddy Creek near Emery, Station 09330500
Average Flow
Historical Average (1953-2012)
Muddy Creek Tract Survey (2001-04)
Average Annual Flow (cfs)
Water Year (Oct-Sept)
0
10
20
30
40
50
60
70
80
90
100
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
1993
1997
2001
2005
2009

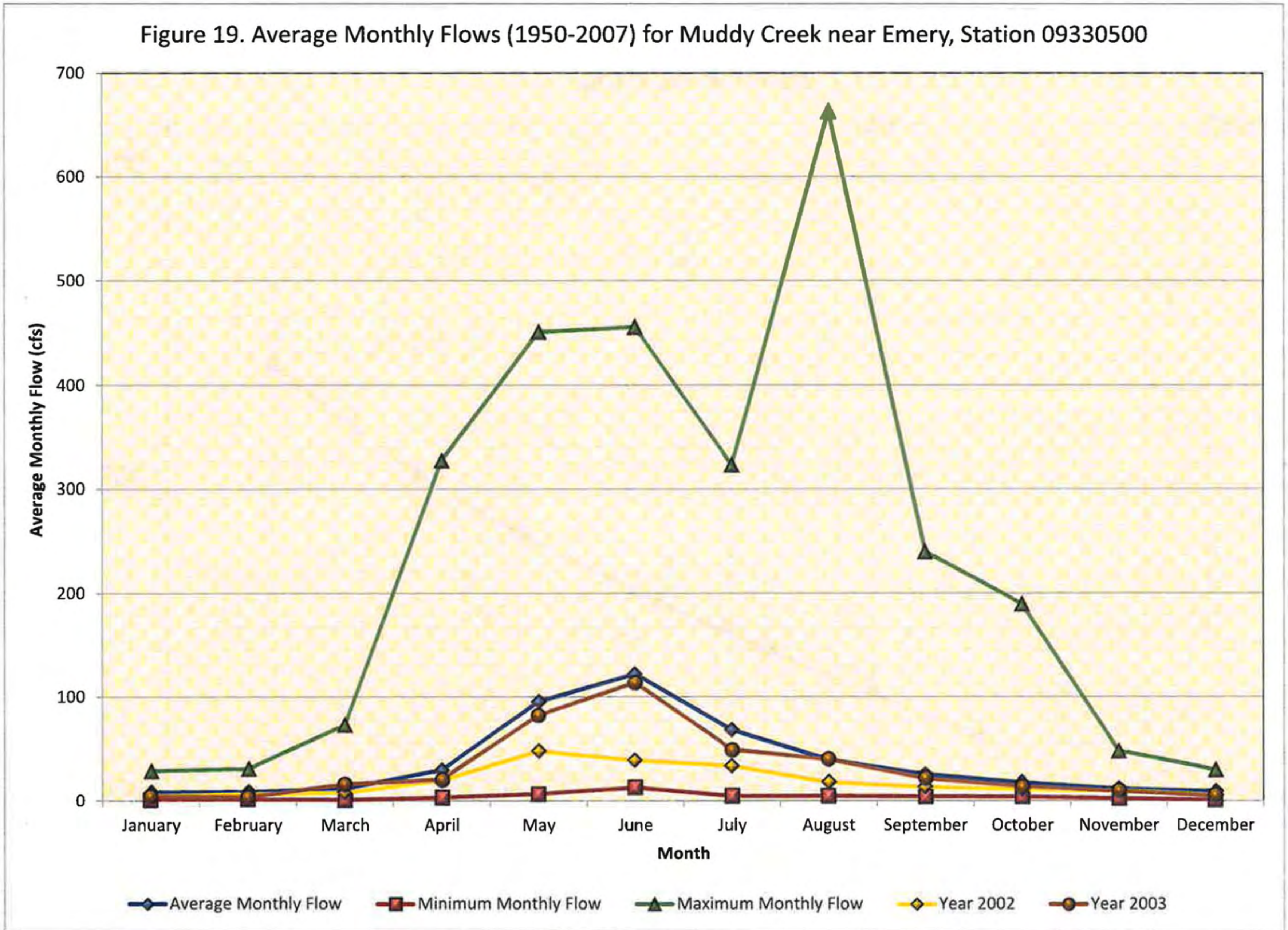


Figure 19. Average Monthly Flows (1950-2007) for Muddy Creek near Emery, Station 09330500
700
600
500
400
300
200
100
0
Average Monthly Flow (cfs)
January
February
March
April
May
June
July
August
September
October
November
December
Month
Average Monthly Flow
Minimum Monthly Flow
Maximum Monthly Flow
Year 2002
Year 2003

Figure 20. Flood Frequency Analysis Annual Maximum for 60-Year Record @ Muddy Creek near Emery, Station 09330500

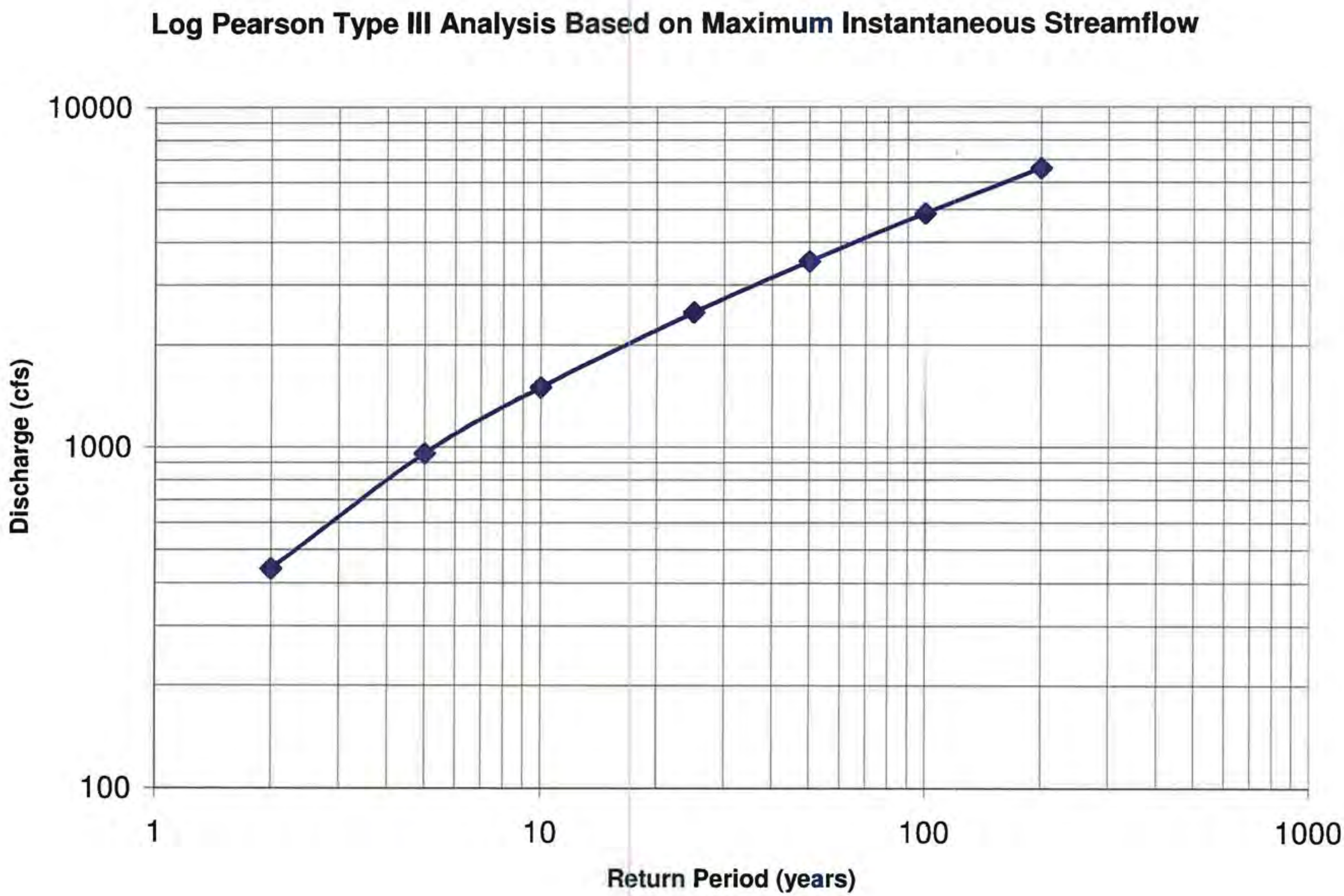


Figure 21. M_STR8 Field Parameters

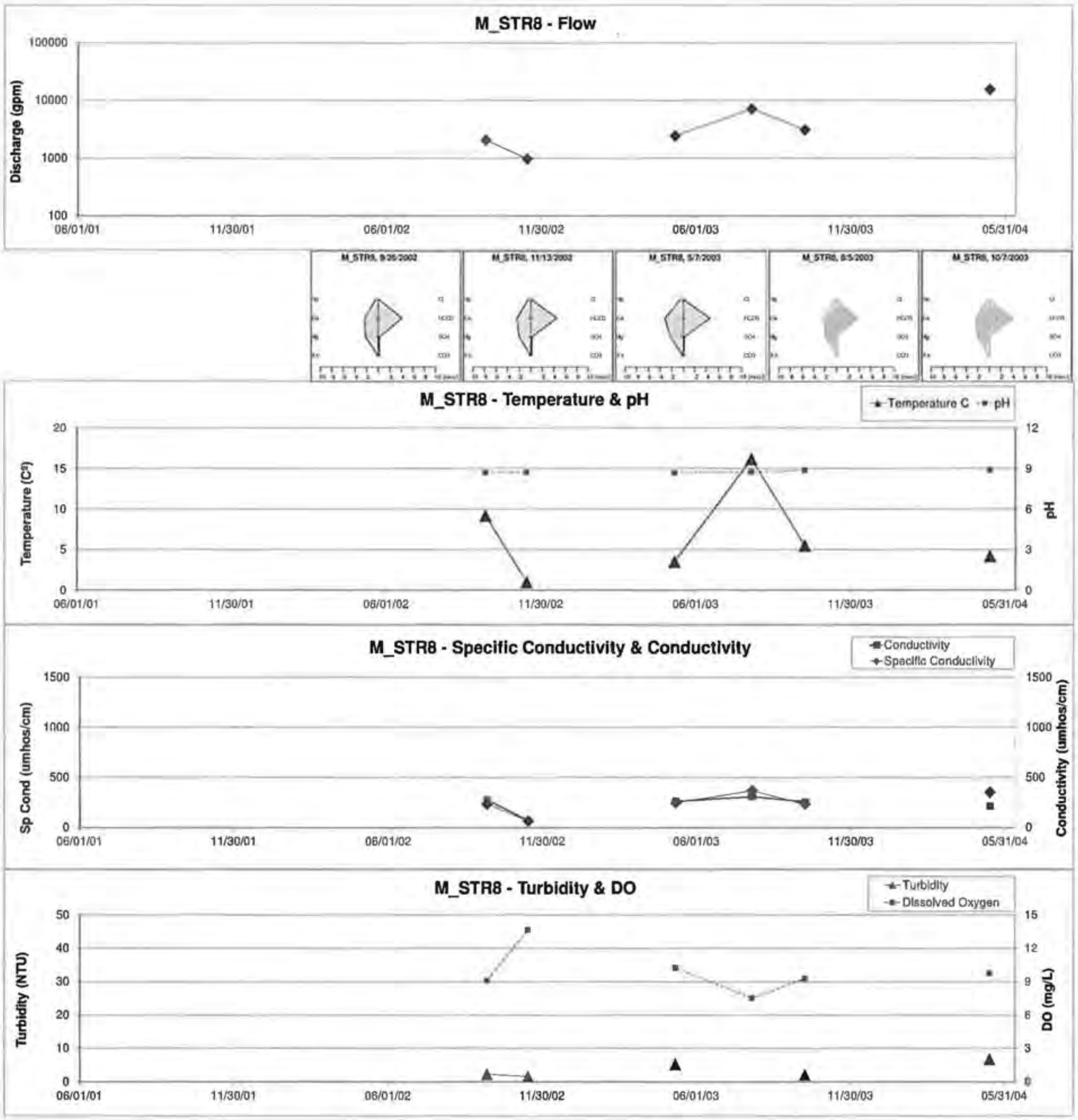


Figure 22. M_STR1 Field Parameters

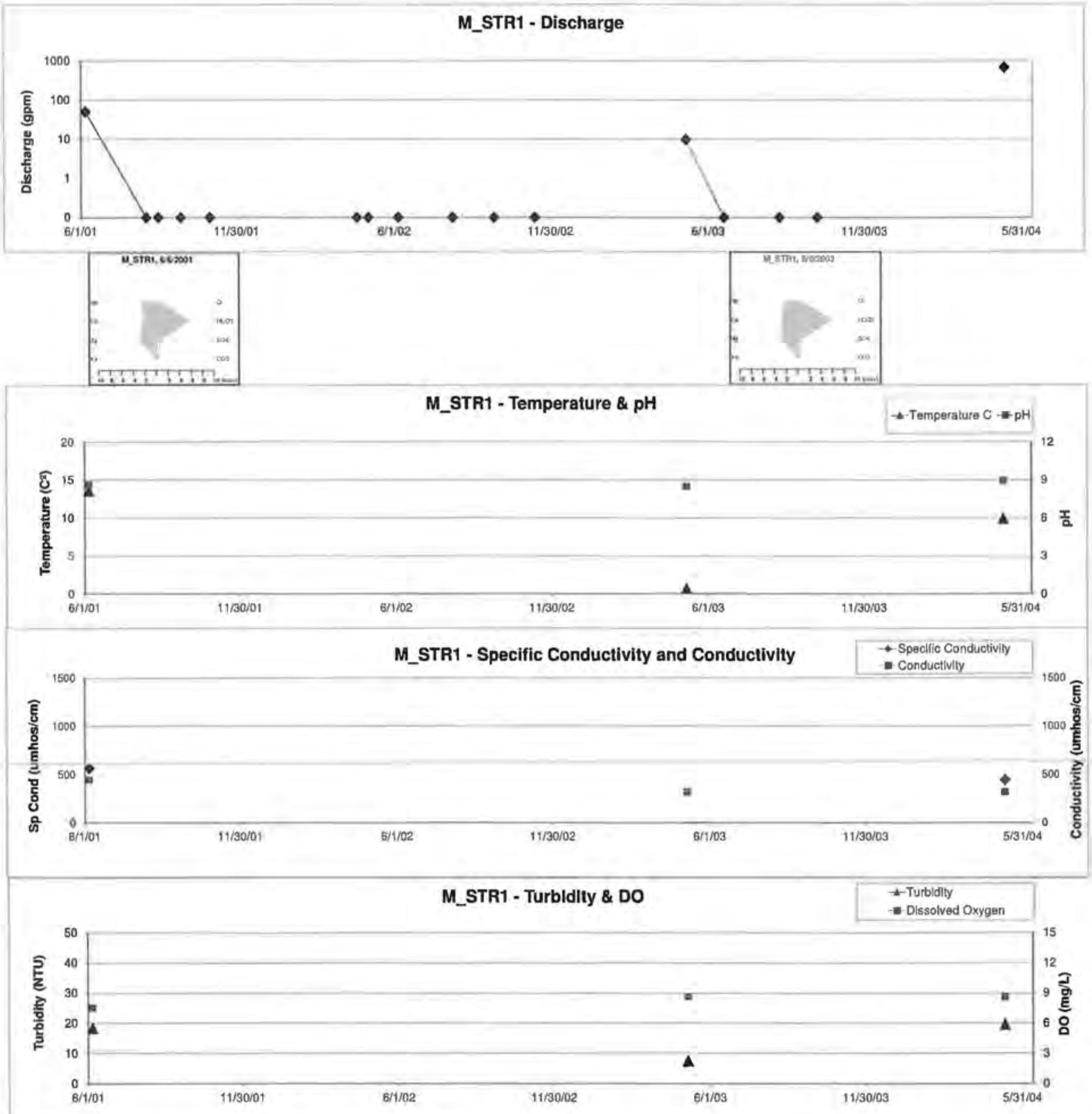


Figure 23. M_STR2 Field Parameters

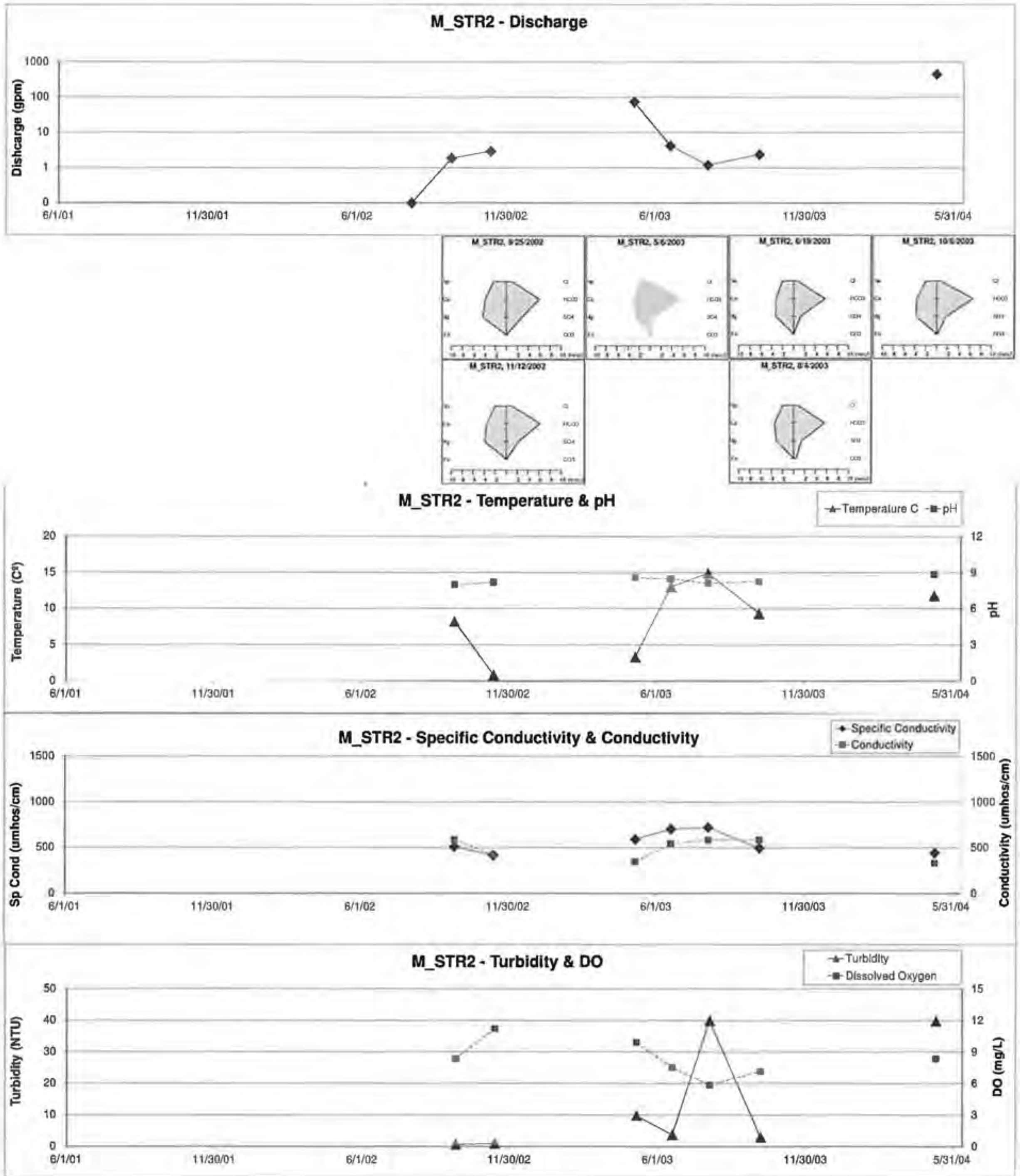


Figure 24. M_STR3 Field Parameters

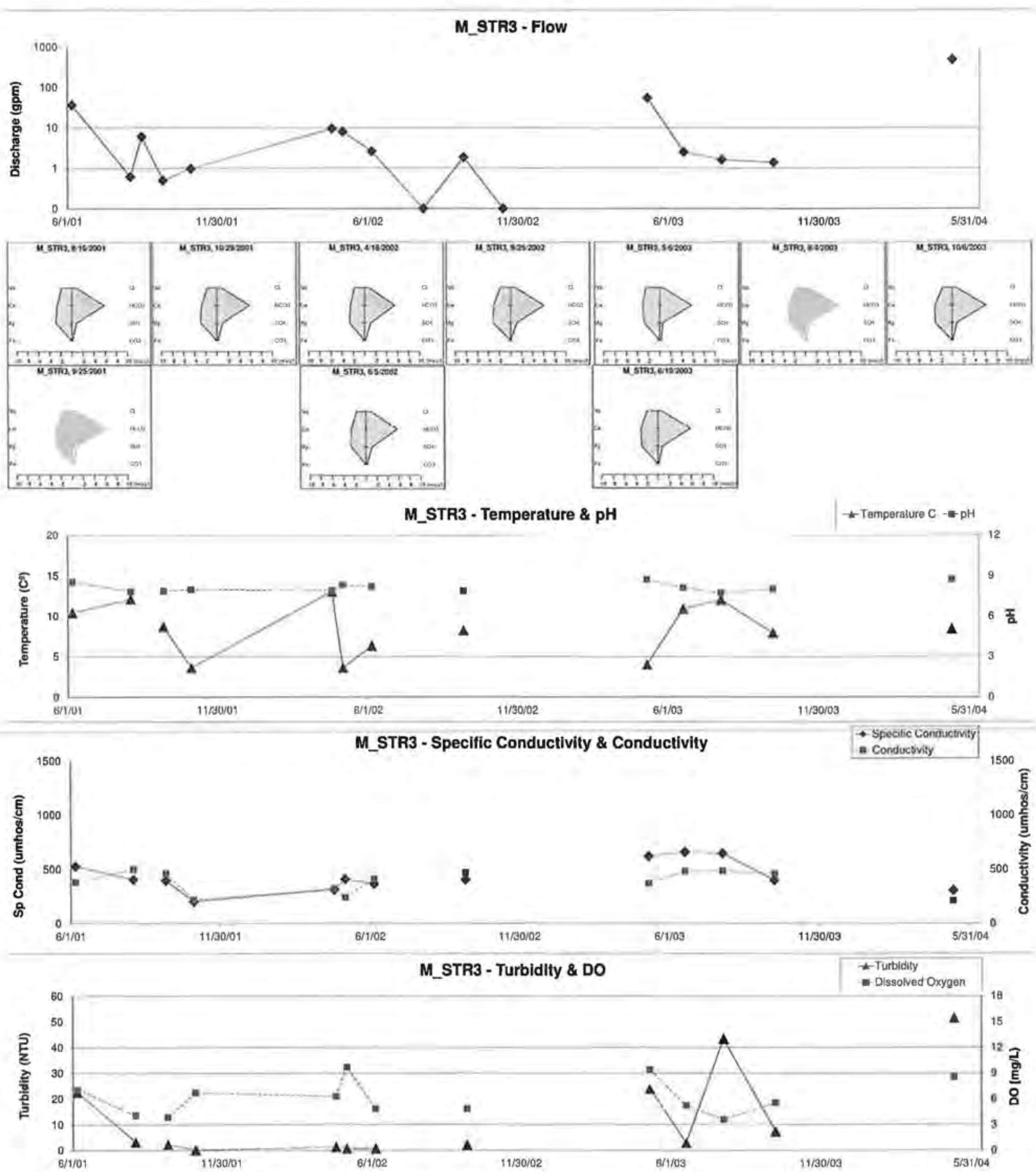


Figure 25. M_STR4 Field Parameters

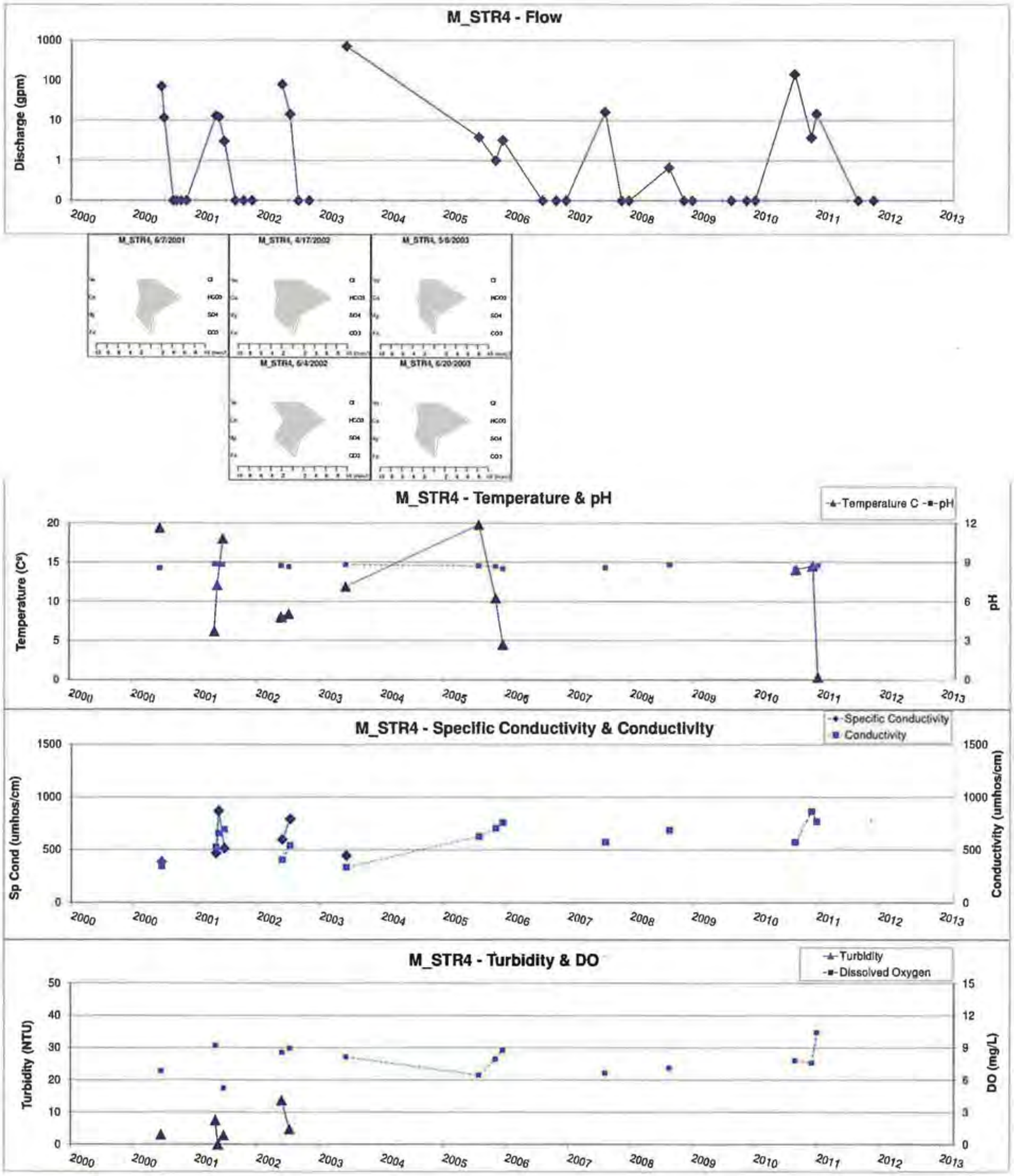


Figure 26. M_STR5 Field Parameters

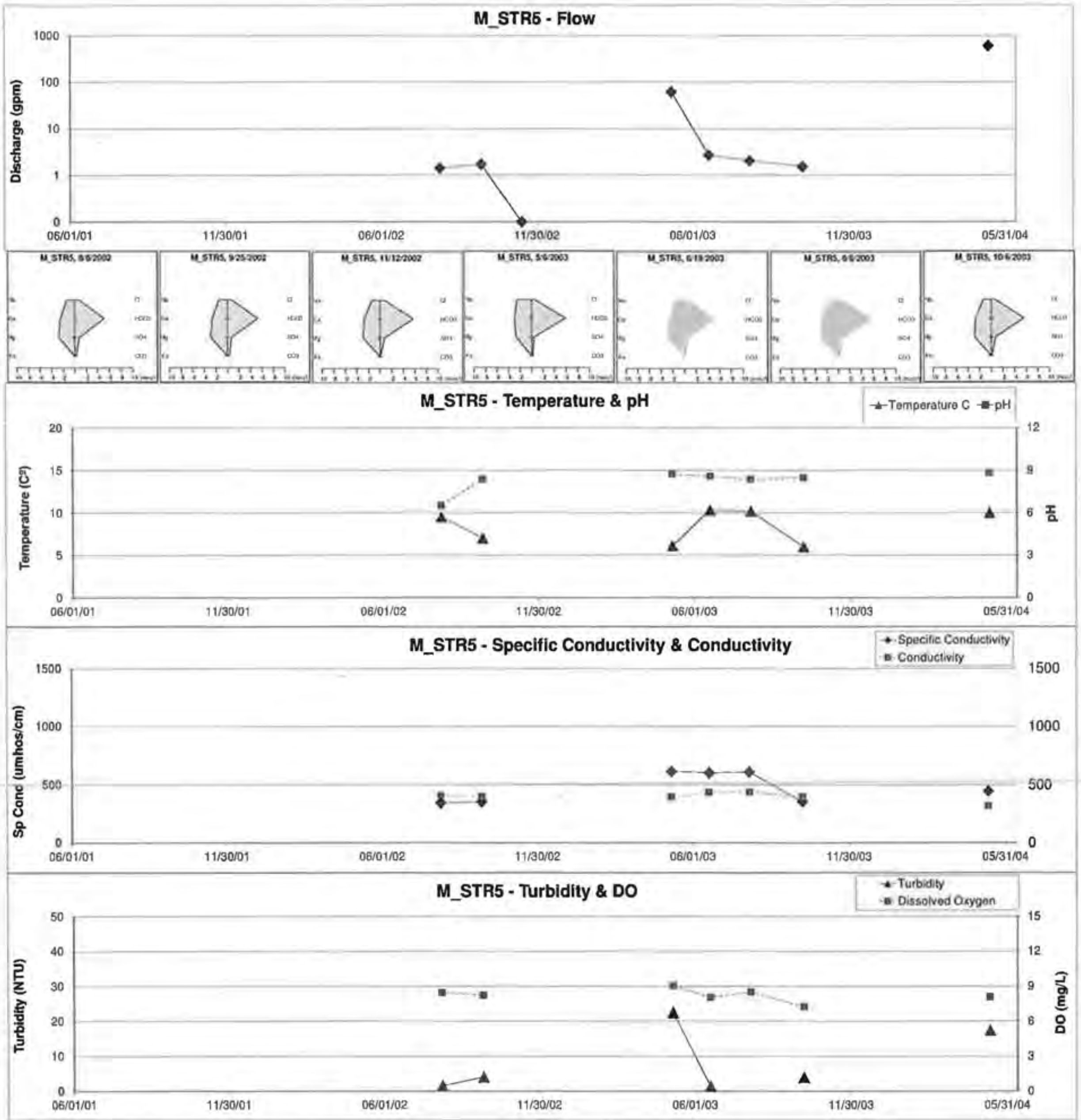
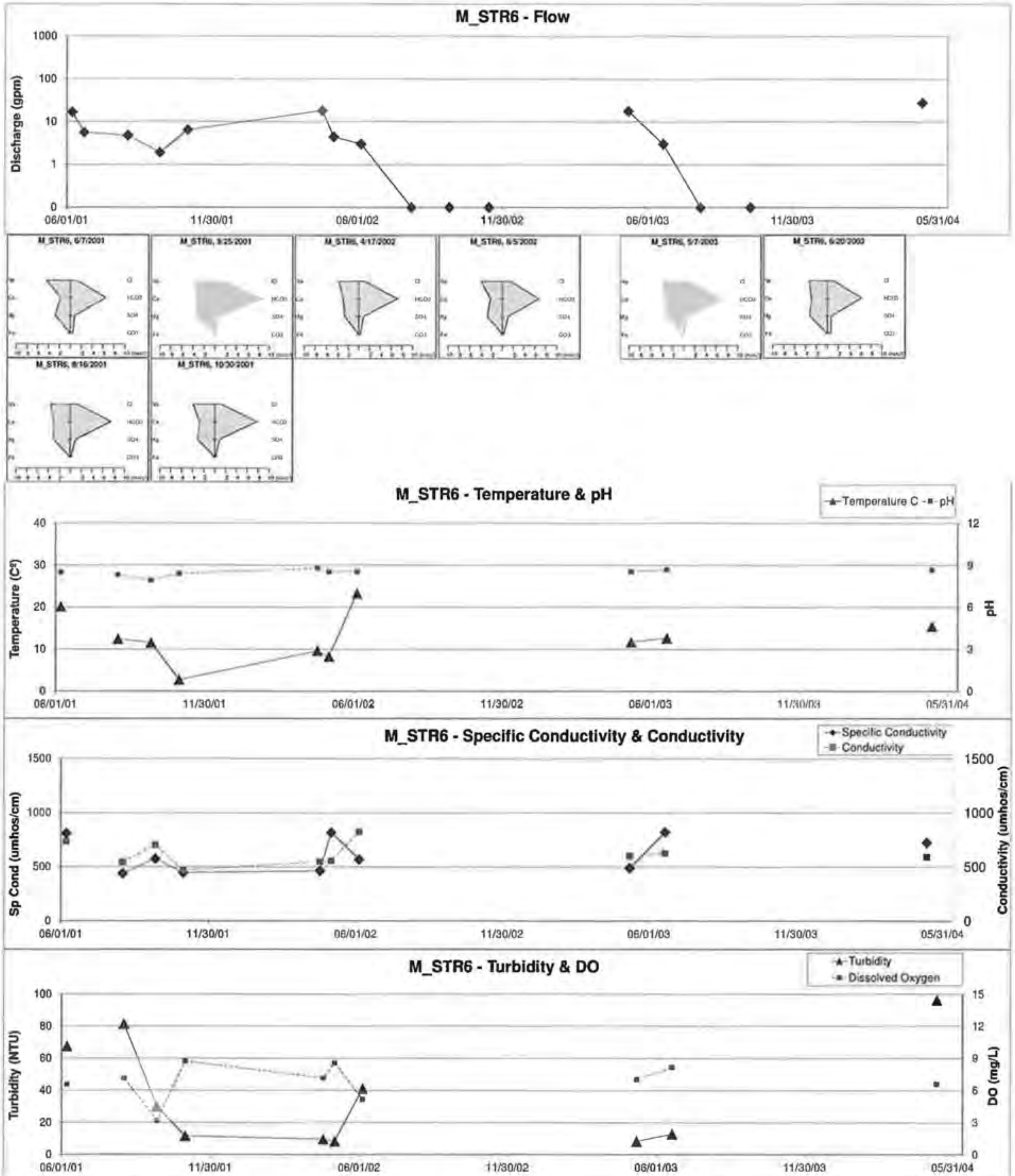


Figure 27. M_STR6 Field Parameters



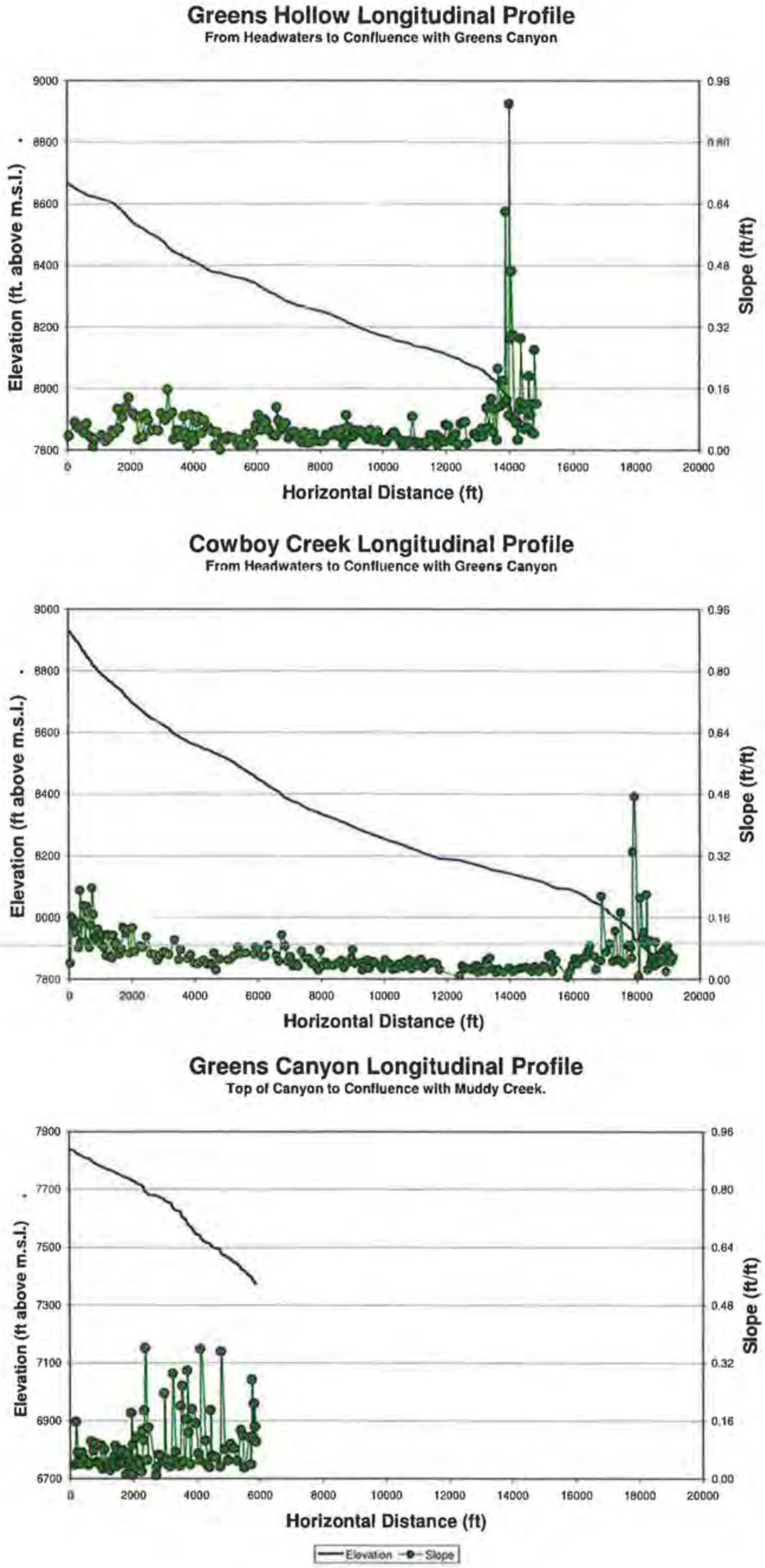


Figure 28. Longitudinal Survey of Greens Canyon and Tributaries. Note the dotted line represents channel slope (right axis) and the smoothed line represents channel elevation (left axis).

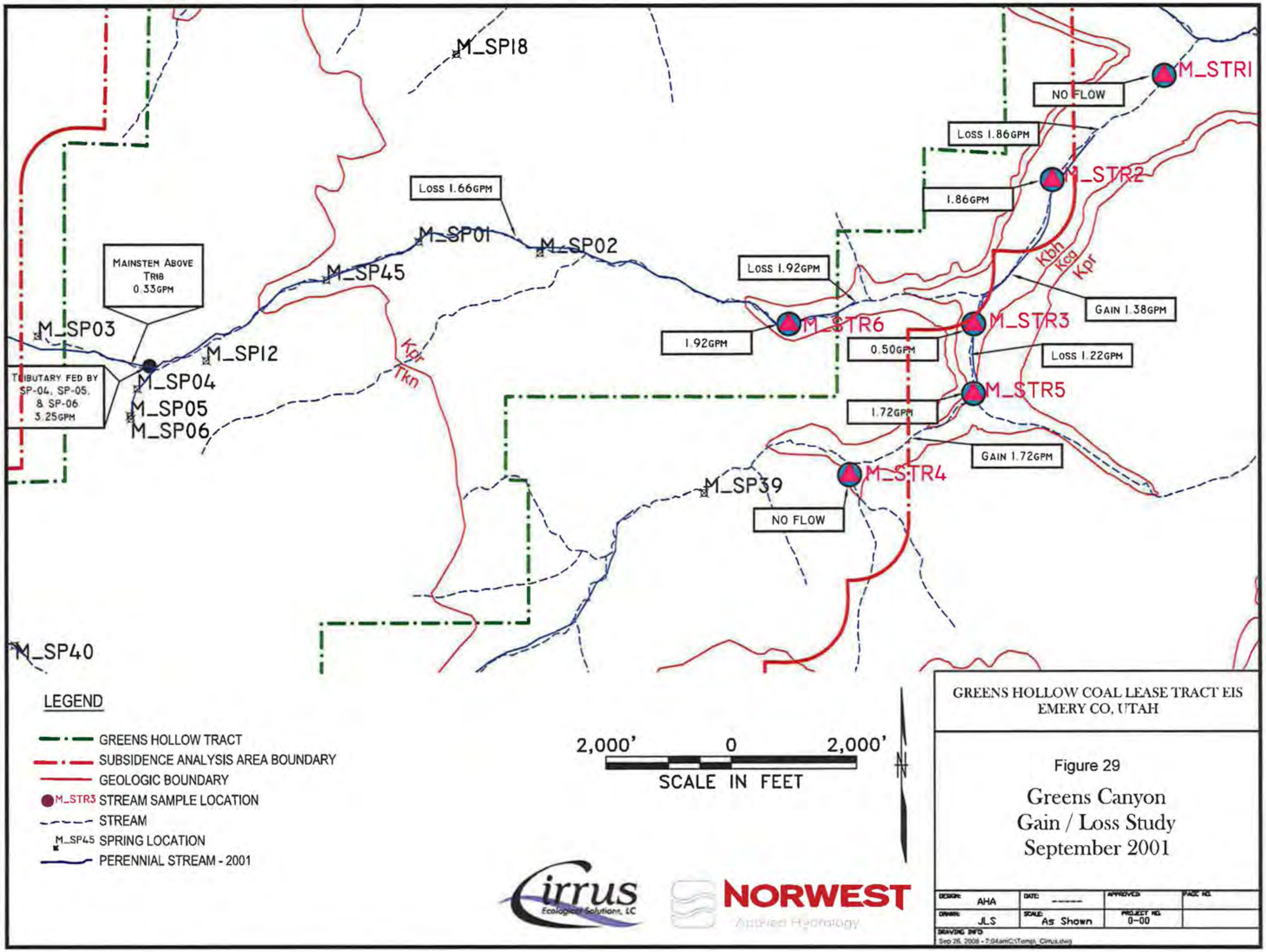


Figure 29

Greens Canyon Gain / Loss Study September 2001

Figure 30 M_STR9 Field Parameters

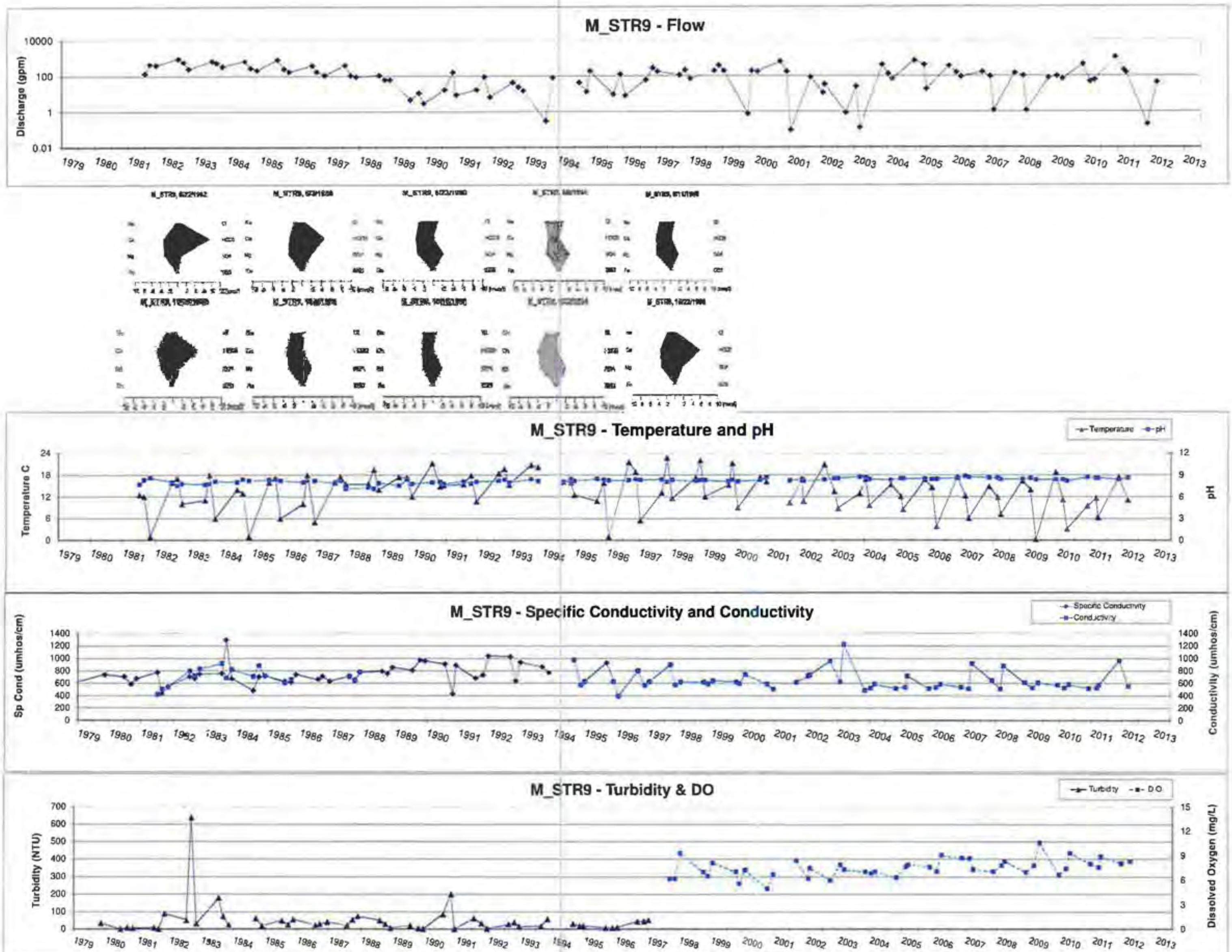
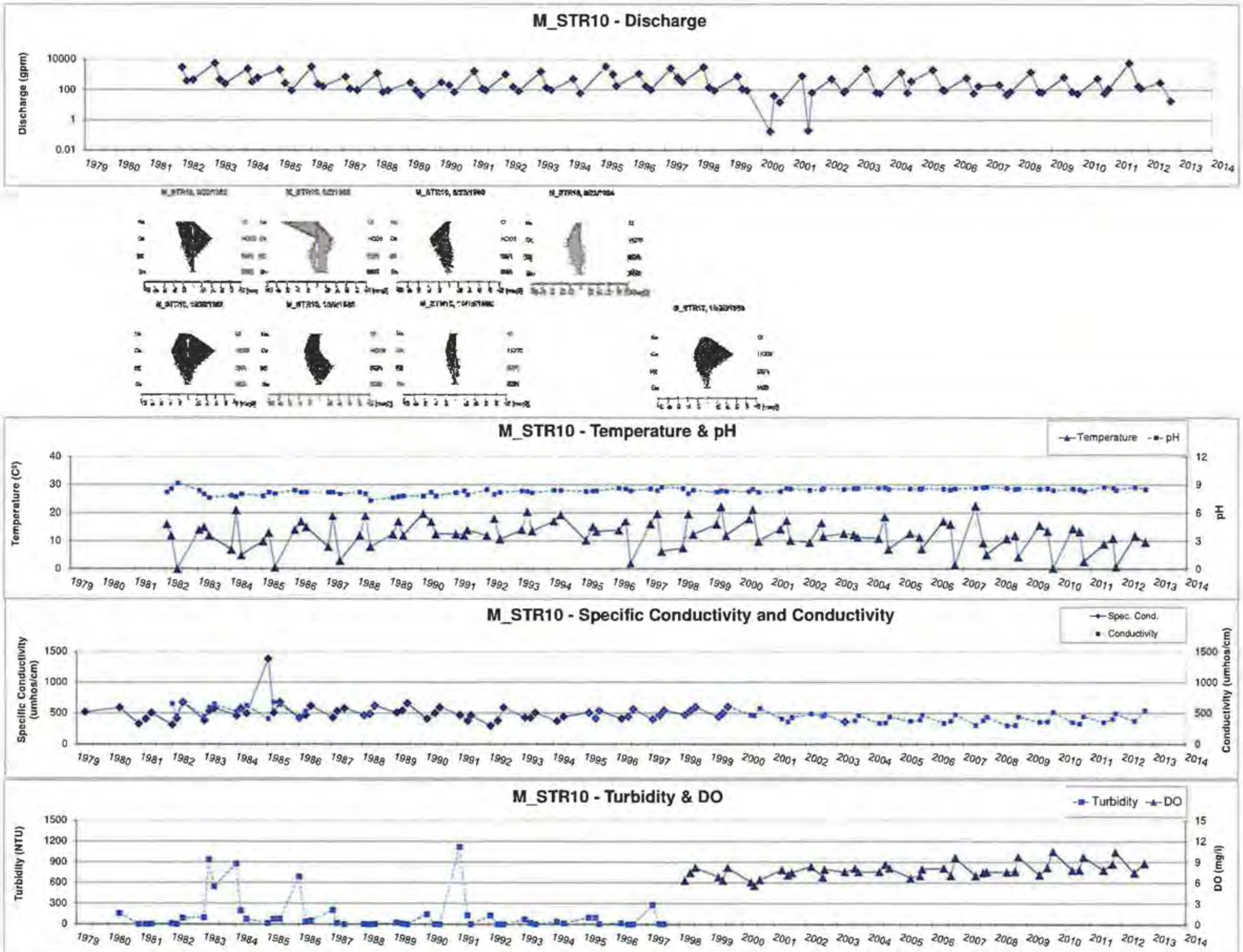


Figure 31. M_STR10 Field Parameters



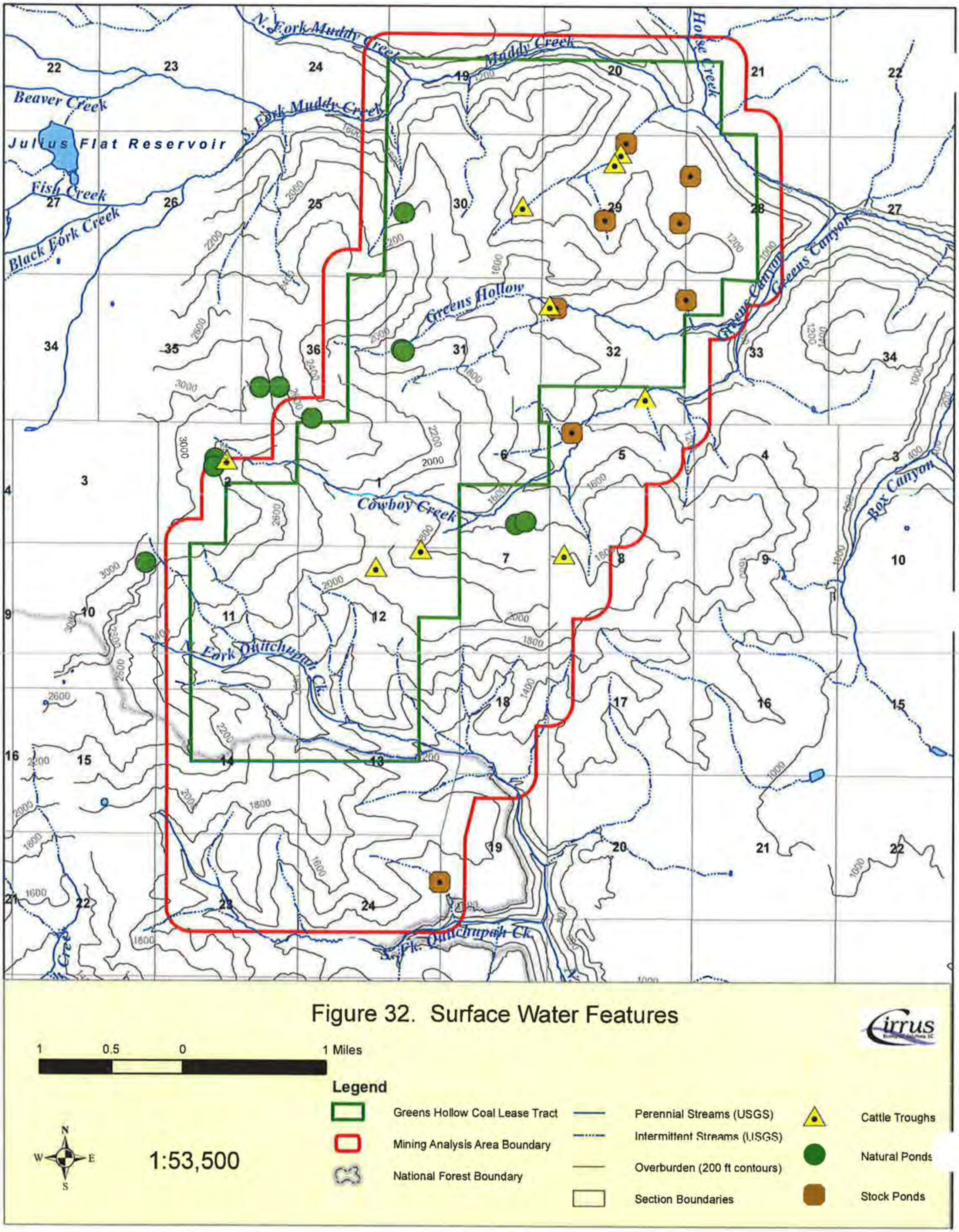


Figure 32. Surface Water Features

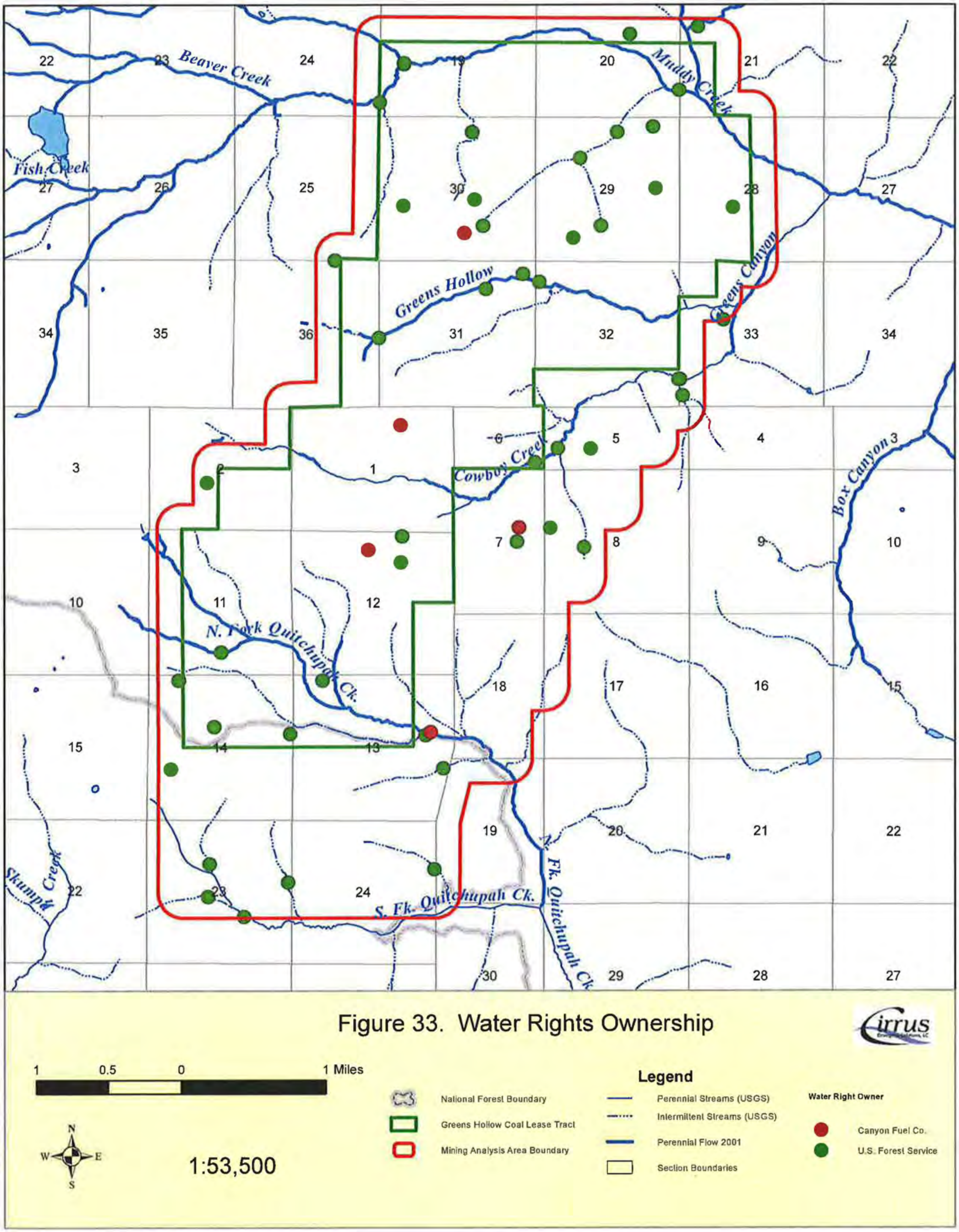


Figure 33. Water Rights Ownership

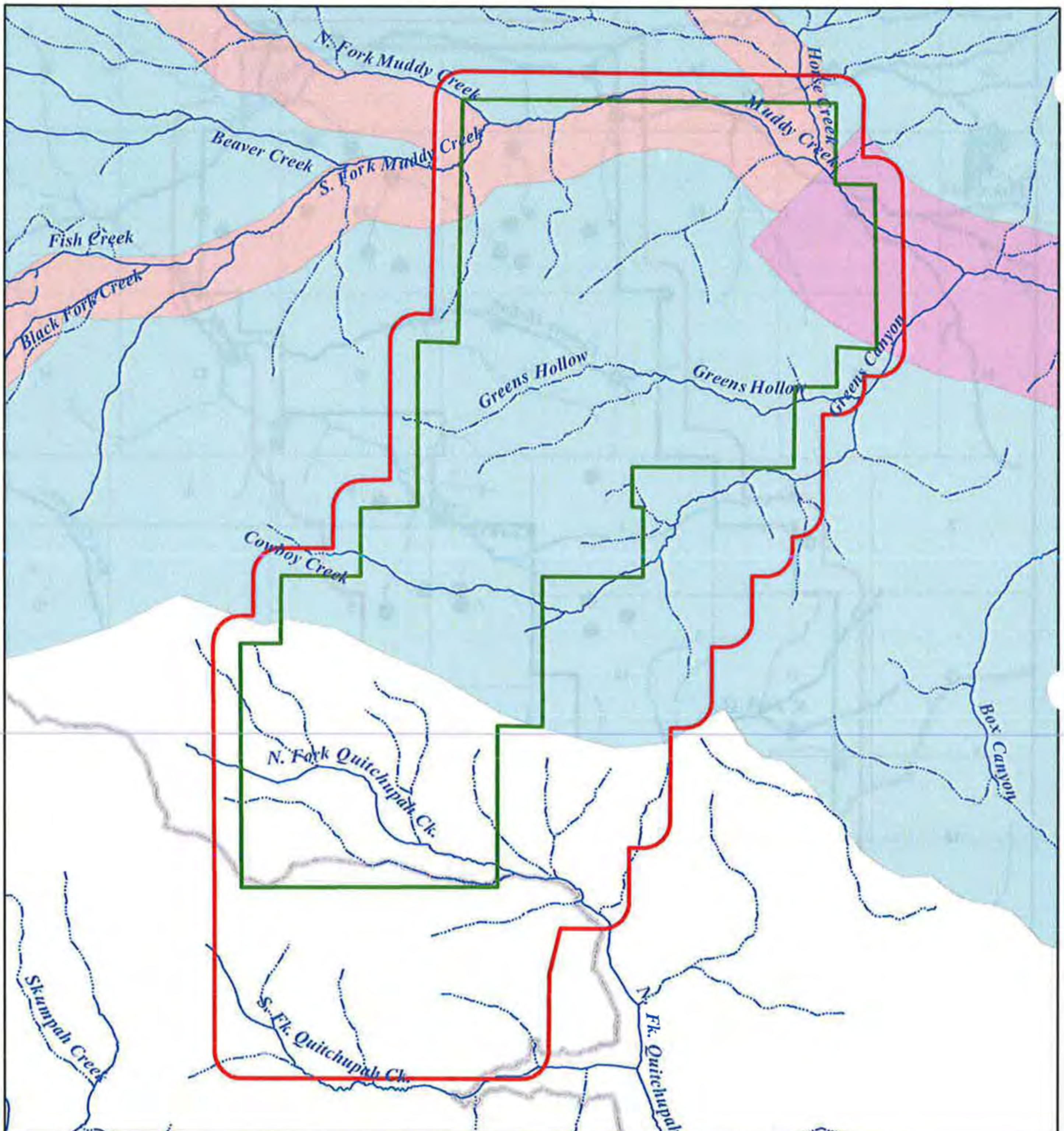


Figure 34. Drinking Water Protection Zones

1 0.5 0 1 Miles

1:53,500

Legend

- National Forest Boundary
- Greens Hollow Coal Lease Tract
- Mining Analysis Area Boundary

Drinking Water Protection Zones
- Zone 1
- Zone 2
- Zone 4

- Perennial Streams (USGS)
- Intermittent Streams (USGS)

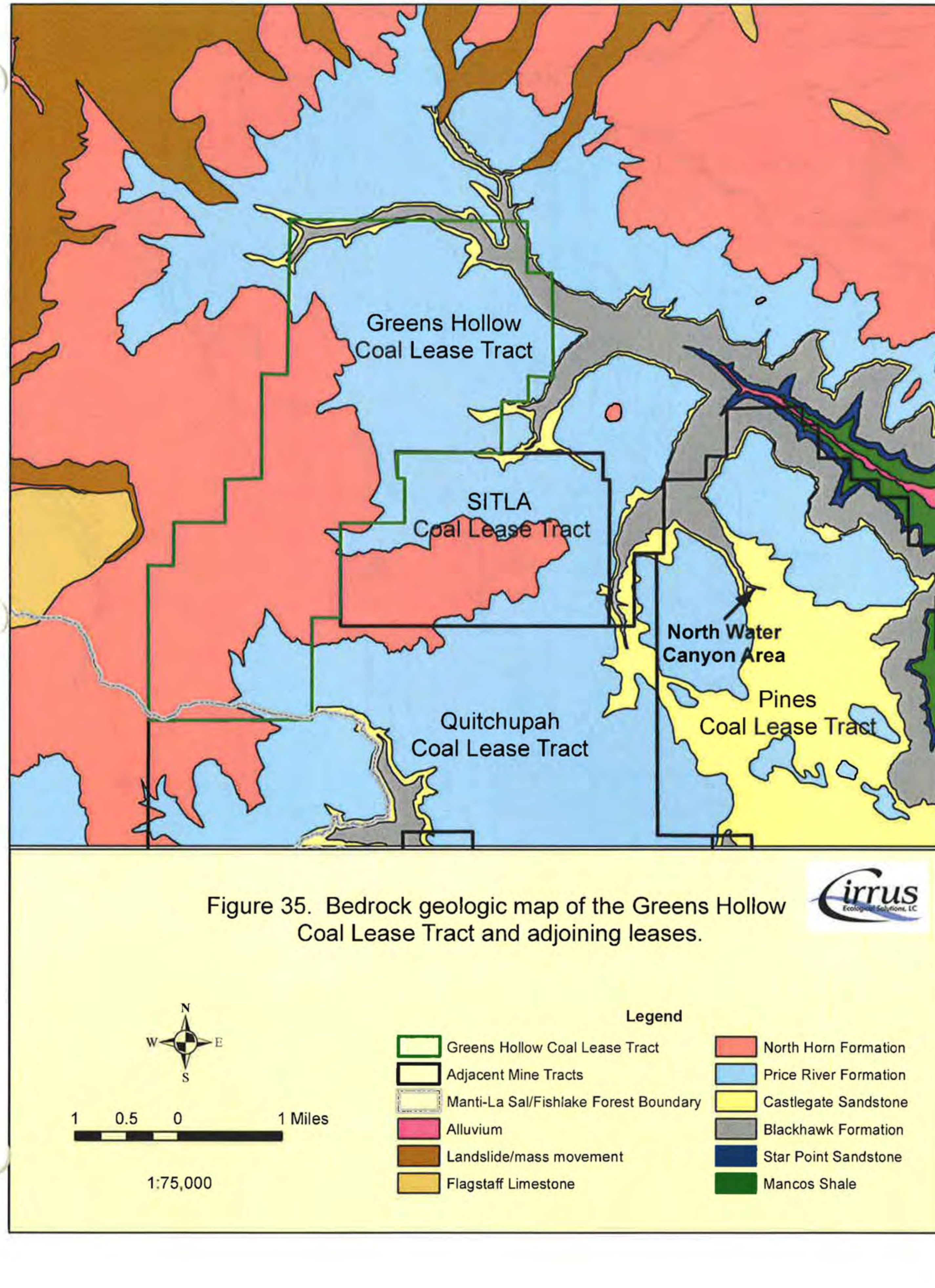


Figure 35. Bedrock geologic map of the Greens Hollow Coal Lease Tract and adjoining leases.

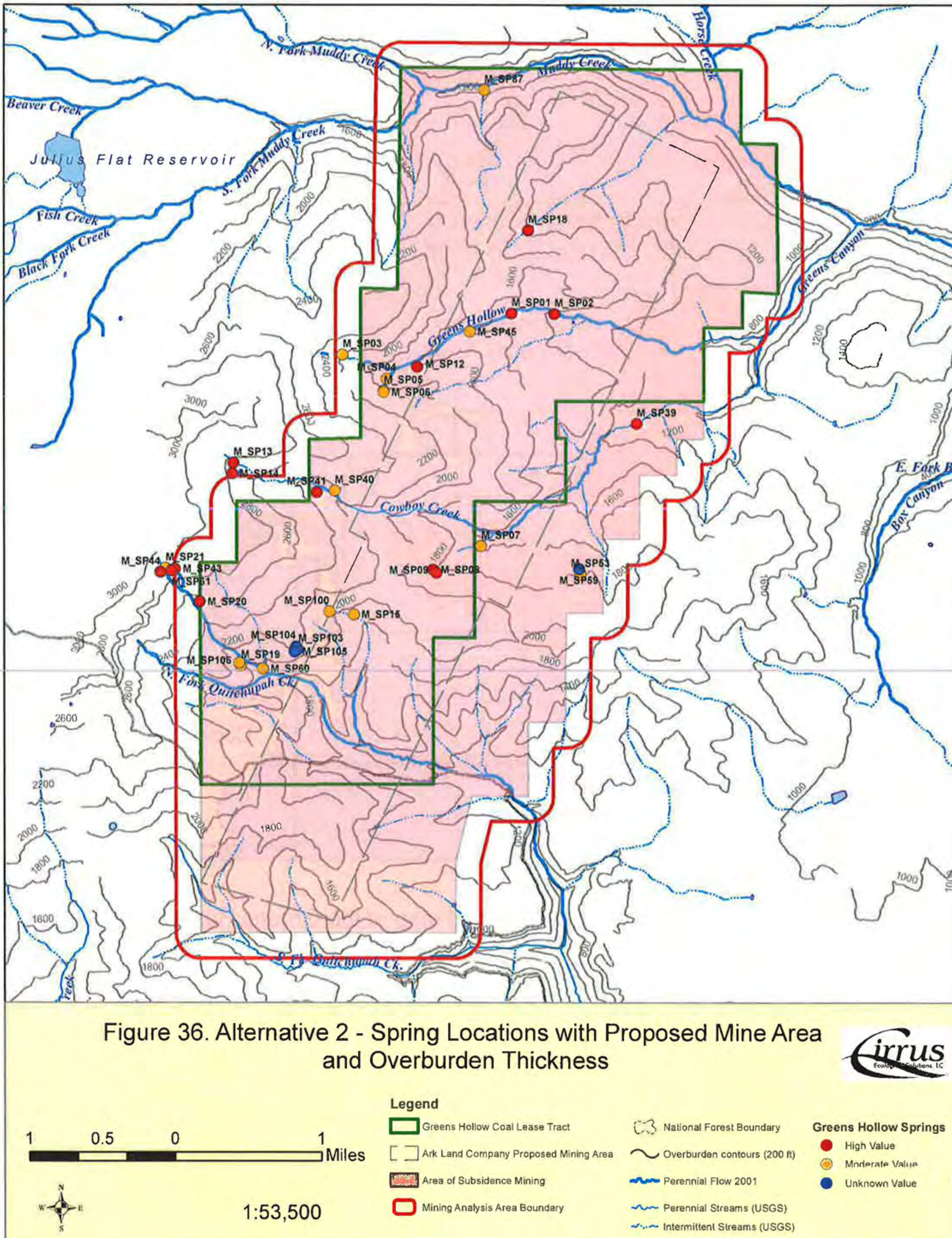
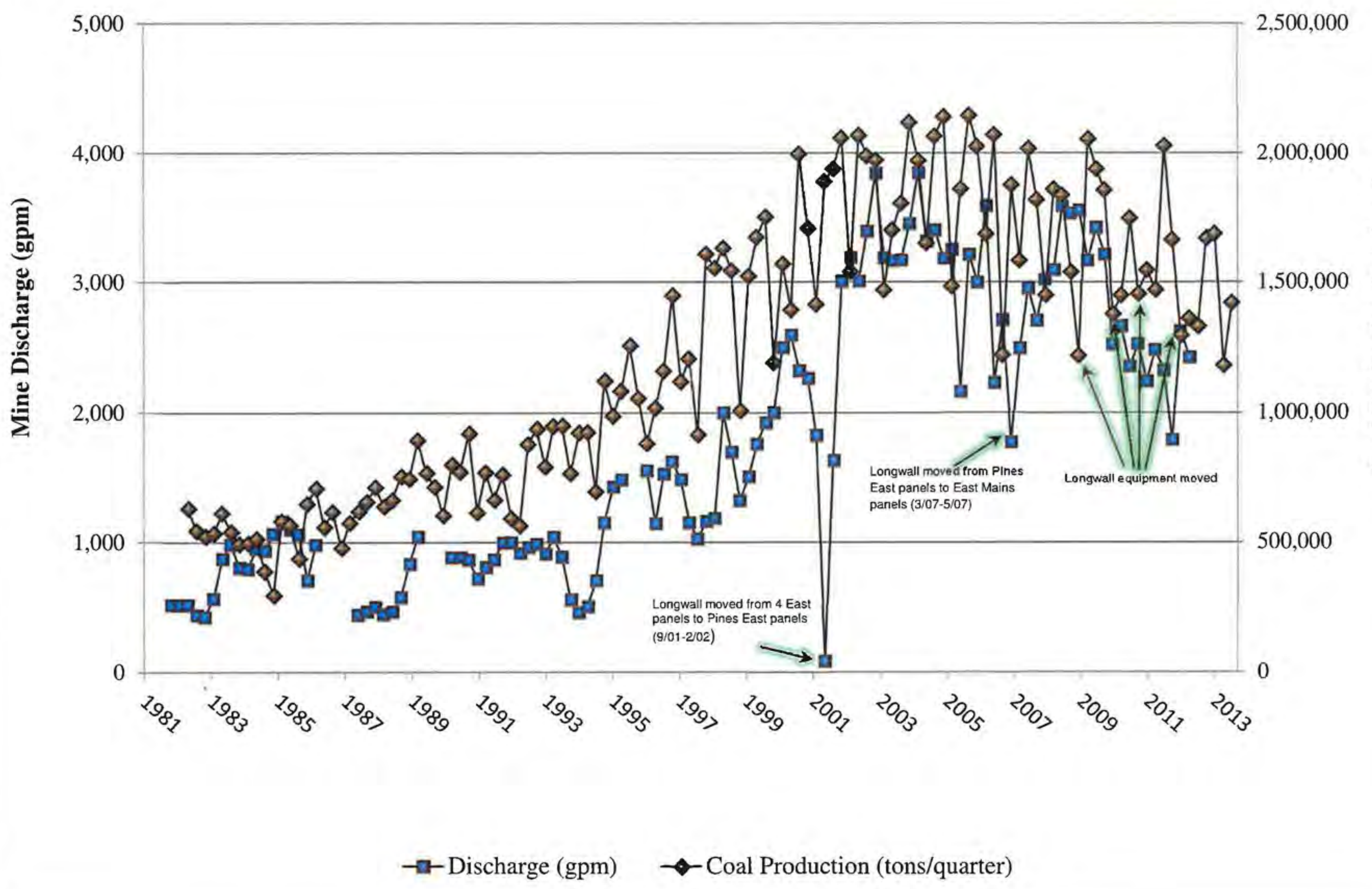
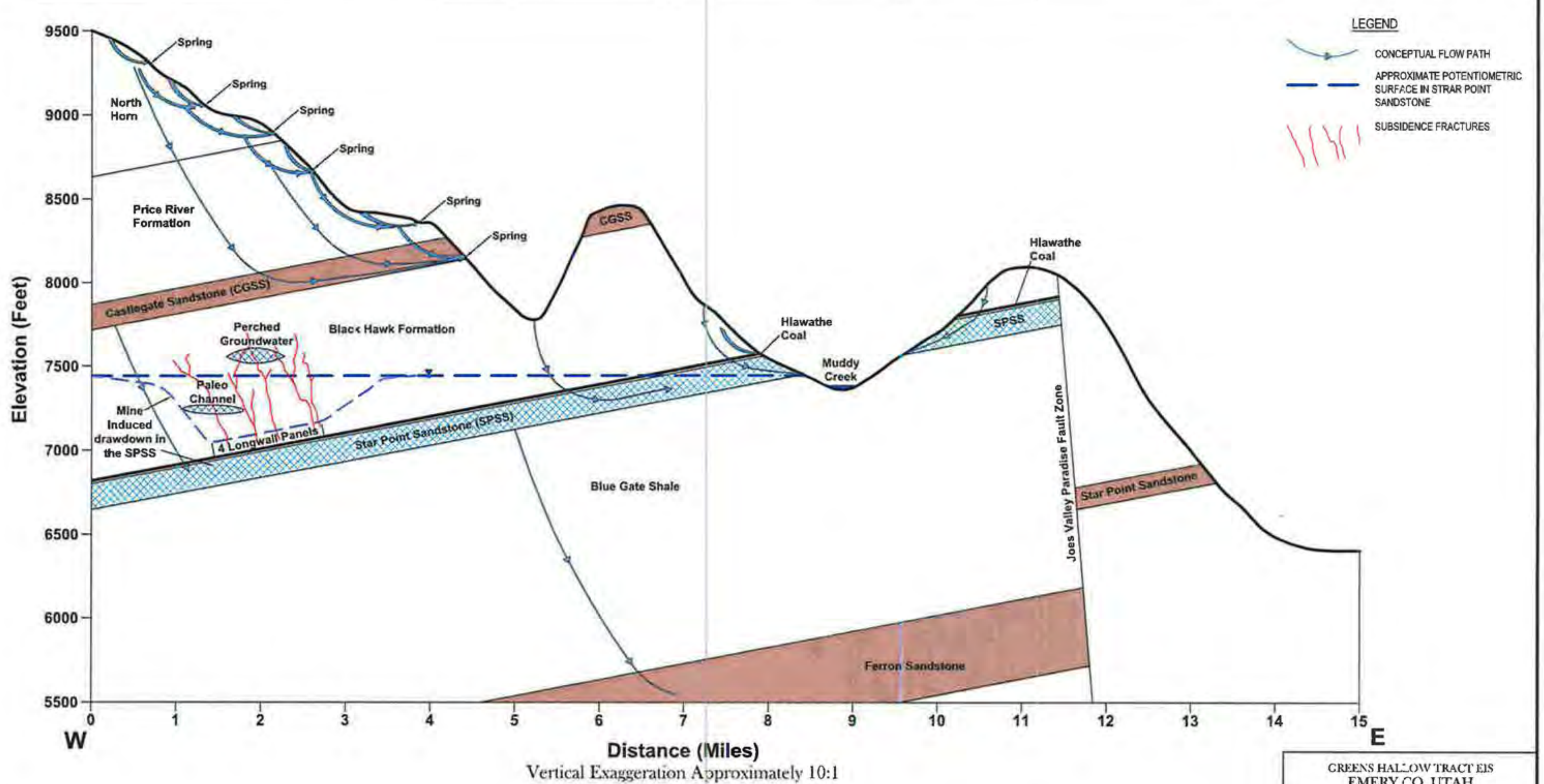


Figure 36. Alternative 2 - Spring Locations with Proposed Mine Area and Overburden Thickness

Figure 37. SUFCO Mine Discharge and Coal Production (1982-2013)





GREENS HALLOW TRACT EIS
EMERY CO. UTAH

Figure 38

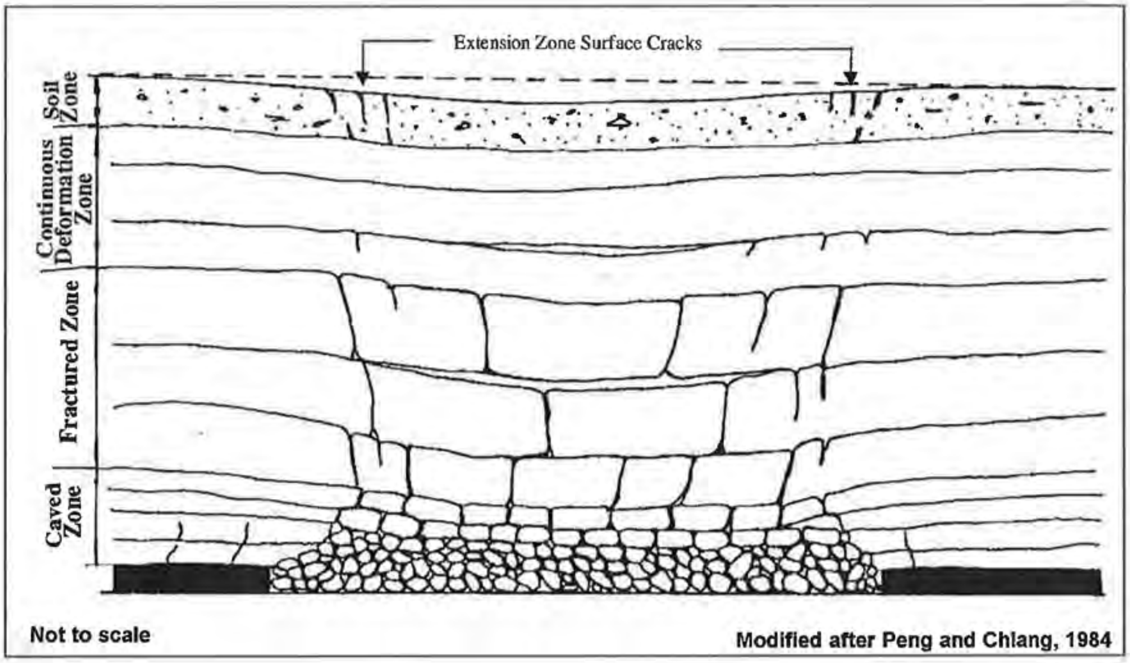
Conceptual Groundwater Model

Cirrus

NORWEST

AHA			
JLS	As Shown	0-00	

Figure 39. Subsidence Zones above a Longwall Panel.



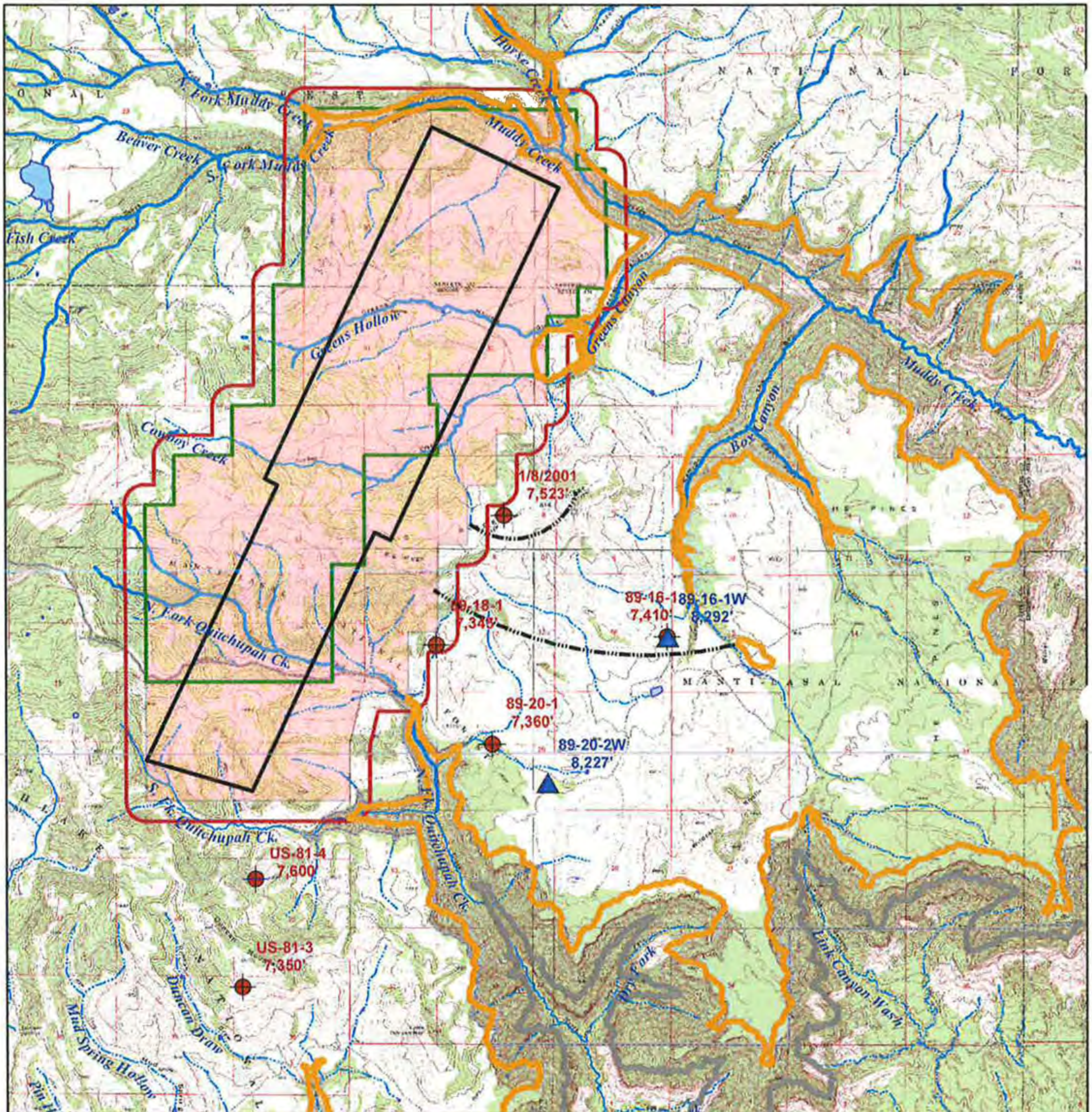


Figure 40. Water Level Elevation in Castlegate Sandstone and Blackhawk Formations.

Cirrus Ecological Solutions, LC

1 0.5 0 1 Miles

1:75,500

Legend

- Greens Hollow Coal Lease Tract
- Ark Land Company Proposed Mining Area
- Area of Subsidence Mining
- Mining Analysis Area Boundary
- National Forest Boundary
- Perennial Flow 2001
- Perennial Streams (USGS)
- Intermittent Streams (USGS)
- Base of Blackhawk Formation
- Castlegate Wells
- Blackhawk Wells
- Potentiometric contour for Hiawatha Coal
- Top of Blackhawk/Base of Castlegate

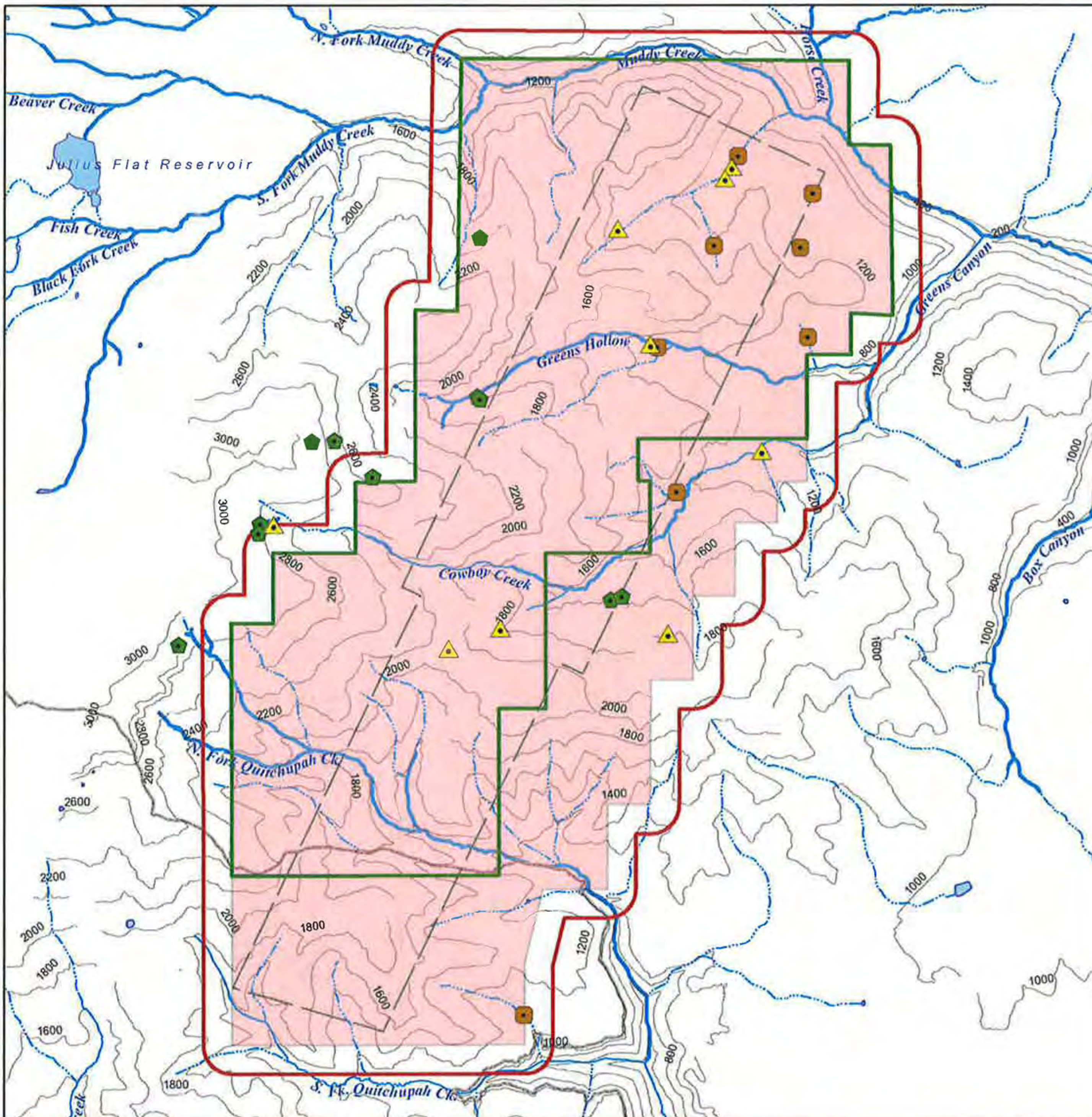


Figure 41. Alternative 2 - Surface Water Features with Mine Plan and Overburden Thickness

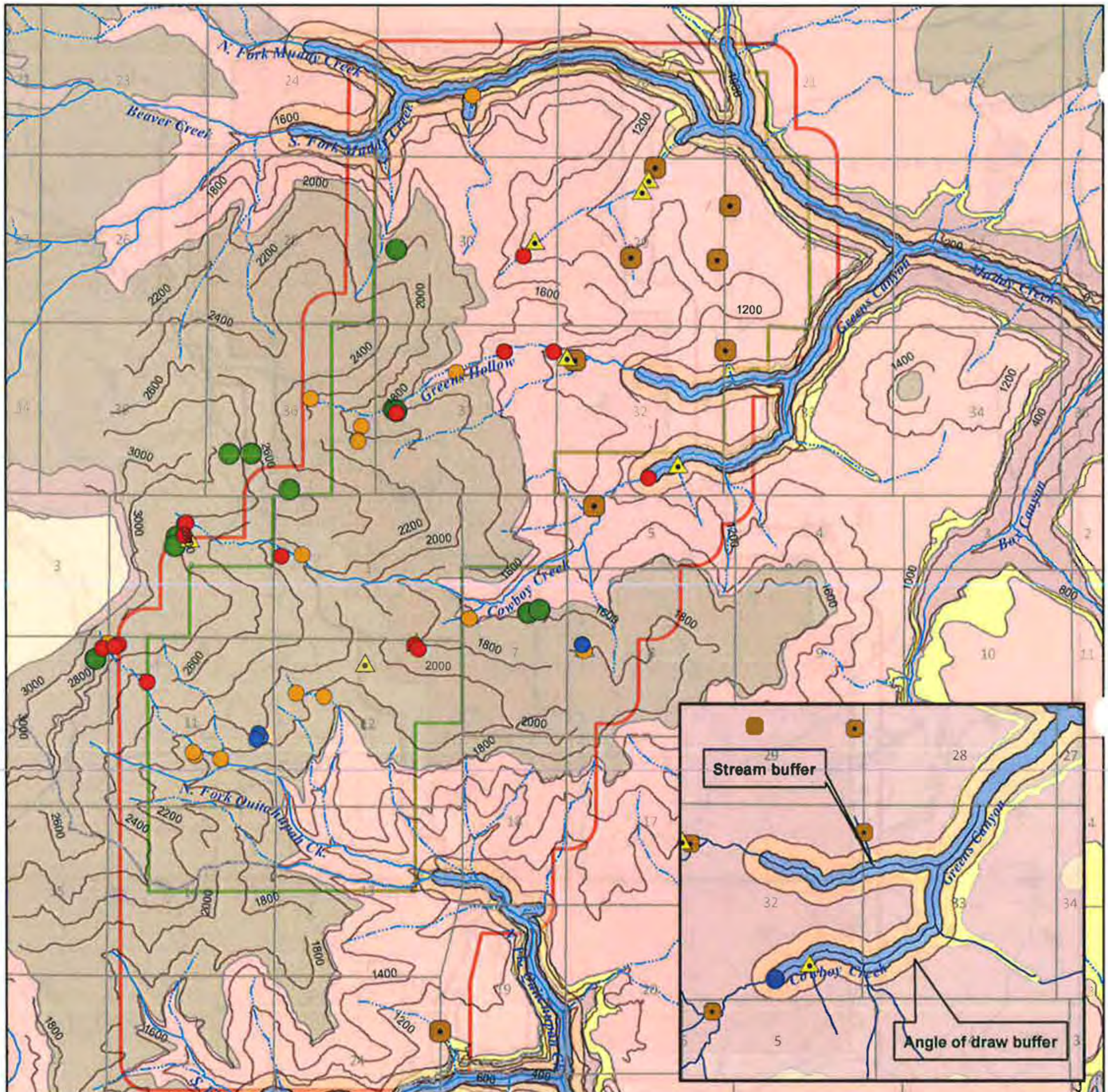


Figure 42. Stream Buffer Development

1 0.5 0 1 Miles

1:53,500

Legend
National Forest Boundary
Greens Hollow Coal Lease Tract
Mining Analysis Area Boundary
Stream Buffer
Angle of Draw Buffer
Cattle Troughs
Natural Ponds
Stock Ponds
Section Boundaries

Greens Hollow Springs
High Value
Moderate Value
Unknown Value

Geology
Ql Landslide
Tf Flagstaff
TKn North Horn
Kpr Price River
Kcg Castlegate
Kbh Blackhawk

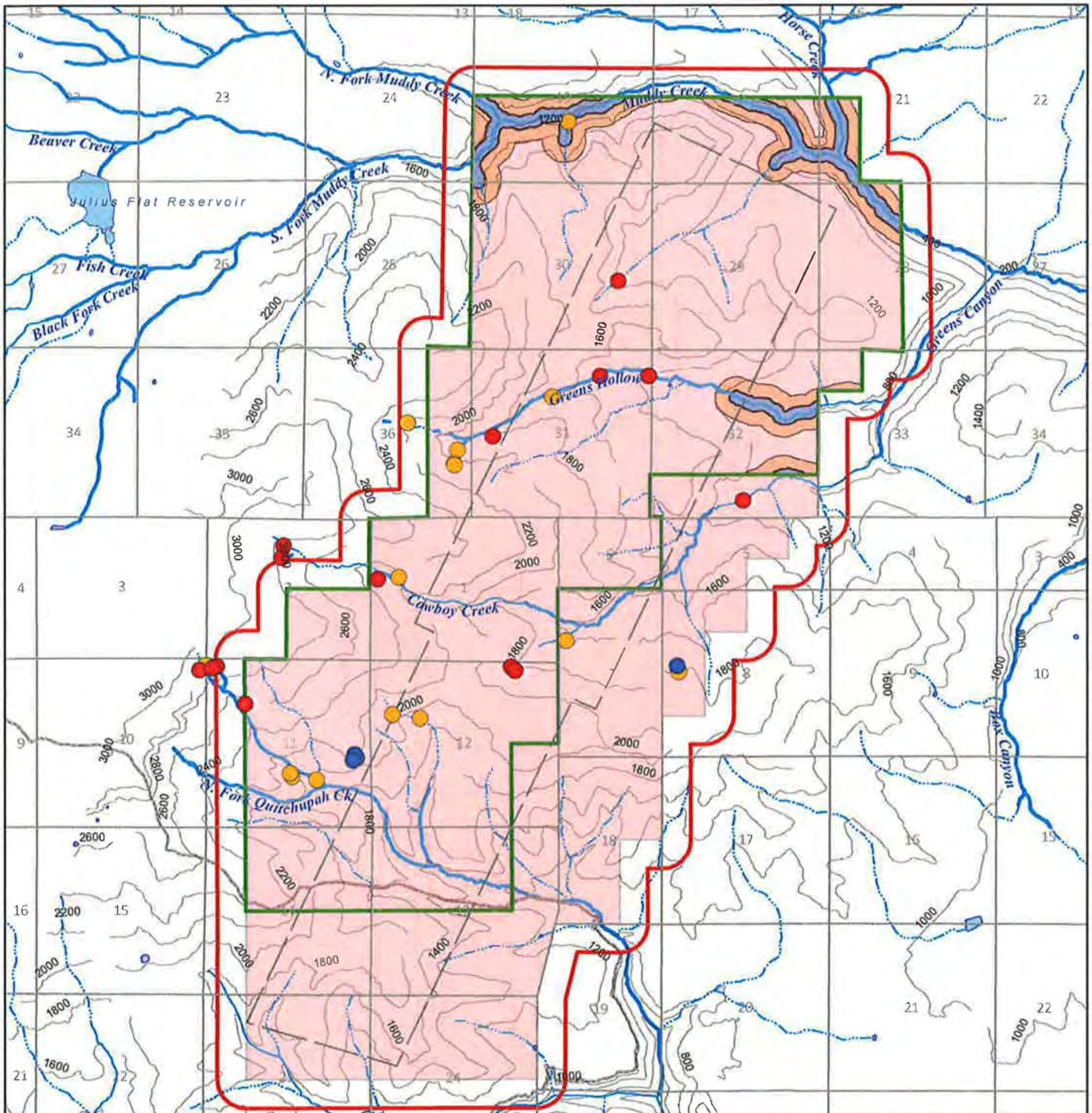


Figure 43. Spring Locations with Areas of High Impact (Alternative 3) and Overburden Thickness

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1 0.5 0 1 Miles

1:53,500

Legend

- Greens Hollow Coal Lease Tract
- Mining Analysis Area Boundary
- Area of Subsidence Mining
- National Forest Boundary
- Conceptual Mining Area
- Section Boundaries
- Overburden contours (200 ft)
- Perennial Flow 2001
- Perennial Streams (USGS)
- Intermittent Streams (USGS)

Greens Hollow Springs

- High
- Moderate
- Unknown
- Stream Buffer
- Angle of Draw Buffer

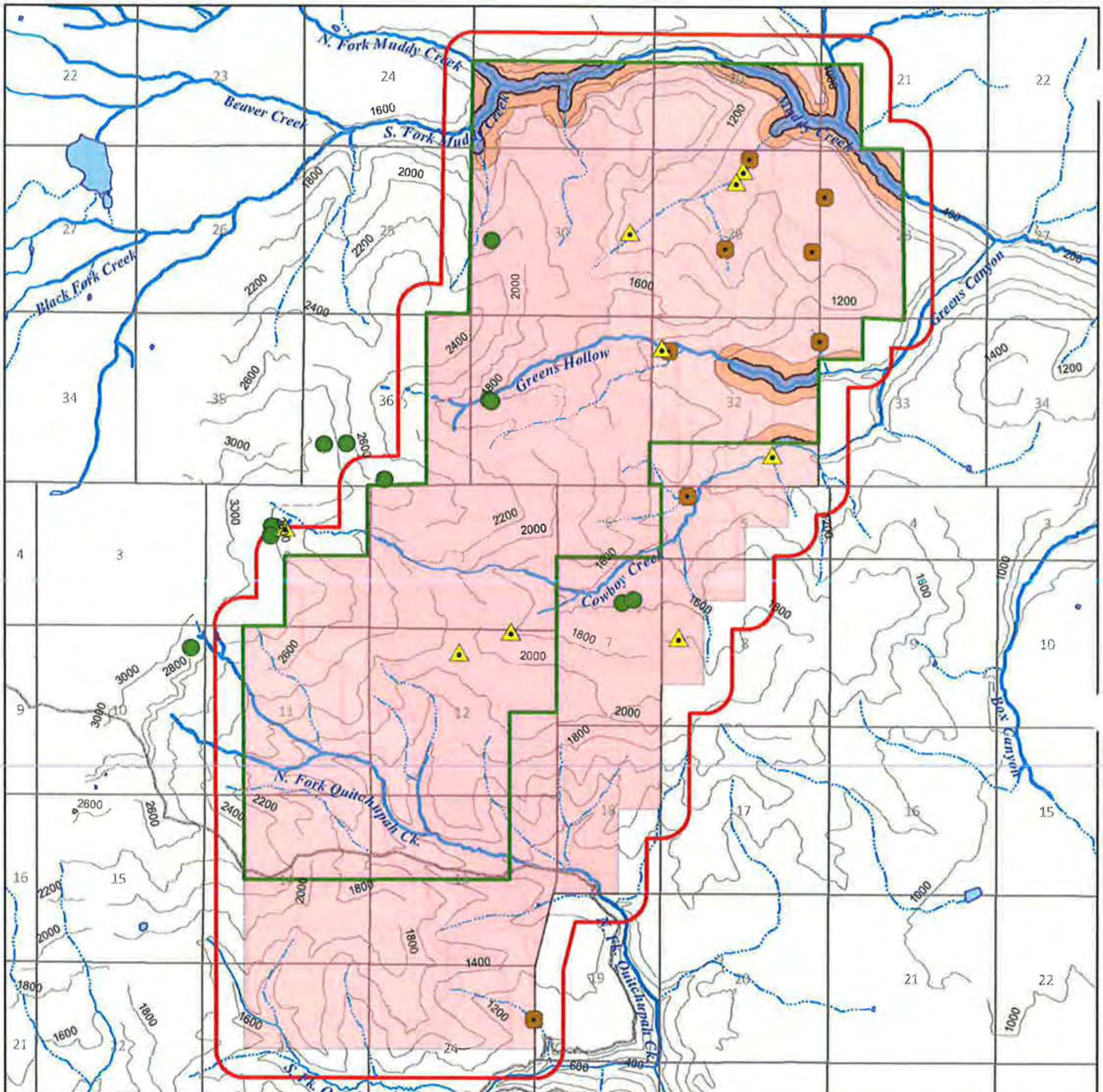


Figure 44. Surface Water Features with Areas of High Impact (Alternative 3) and Overburden Thickness

1 0.5 0 1 Miles

1:53,500

Legend

Greens Hollow Coal Lease Tract
Mining Analysis Area Boundary
Area of Subsidence Mining
National Forest Boundary
Section Boundaries
Overburden contours (200 ft)
Perennial Flow 2001
Perennial Streams (USGS)
Intermittent Streams (USGS)
Stream Buffer
Angle of Draw Buffer
Cattle Troughs
Natural Ponds
Stock Ponds

Cirrus Ecological Solutions, LC

TABLES

Table 1. Spring Location and Field Monitoring Summary of Springs with Measurable Flow.

FORMATION	NAME	LOCATION			MONITORING RESULTS												
			UTM Coordinates		Date		Discharge (gpm)					Specific Conductance (uS/cm)			
		Elevation (ft)	Easting	Northing	Start	End	Average	Maximum	Minimum	Count	No Flow	Average	Maximum	Minimum	Count
	M_SP03	8961	463762	4319529	6/19/01	6/3/04	1.04	1.95	0.08	4	3	378.58	824	76.80	4
	M_SP04	8812	464246	4319267	6/19/01	5/12/04	1.84	3.23	0.75	9	0	687.04	929	379.40	9
	M_SP05	8937	464212	4319133	9/26/02	5/12/04	0.17	0.26	0.08	4	0	686.75	910	524.00	4
	M_SP06	8952	464215	4319121	6/19/01	5/12/04	1.79	2.30	1.47	7	0	682.57	918	474.00	7
	M_SP07	8709	465280	4317433	6/20/01	5/10/04	0.46	1.14	0.21	9	0	655.50	878	441.50	9
	M_SP08	8820	464754	4317178	6/20/01	9/25/12	0.41	1.19	0.01	25	5	657.91	1013	331.70	8
	M_SP09	8849	464791	4317141	6/20/01	5/10/04	0.63	1.00	0.25	2	5	446.70	464	429.40	2
	M_SP12	8739	464583	4319397	6/19/01	6/3/04	0.60	0.94	0.26	6	1	544.18	785	398.70	6
	M_SP13	9637	462562	4318345	6/21/01	6/6/04	6.06	19.00	0.52	4	3	373.03	543	206.10	4
	M_SP14	9584	462545	4318227	6/21/01	6/6/04	22.53	61.40	0.86	5	3	357.80	542	294.70	5
	M_SP15	8811	463884	4316685	7/11/01	6/5/04	1.56	4.82	0.27	5	2	588.26	930	433.20	5
	M_SP19	8968	462644	4316124	7/11/01	6/5/04	2.56	3.13	1.98	7	0	520.50	851	442.90	7
	M_SP20	9395	462191	4316826	7/11/01	6/5/04	2.34	8.62	0.71	7	0	502.36	814	420.30	7
North Horn Formation	M_SP21	9616	461814	4317195	7/11/01	6/5/04	1.84	3.66	0.98	4	3	350.88	558	240.00	4
	M_SP40	9163	463677	4318041	9/26/01	6/6/04	0.40	0.66	0.18	6	0	638.00	900	483.00	6
	M_SP41	9223	463475	4318025	9/26/01	6/6/04	0.75	2.25	0.40	6	0	483.93	799	285.40	6
	M_SP43	9568	461919	4317186	10/3/01	6/5/04	1.03	2.08	0.38	6	0	427.63	638	344.00	6
	M_SP44	9599	461759	4317150	10/3/01	6/5/04	3.48	13.03	0.20	6	0	416.27	721	269.00	6
	M_SP53	8941	466373	4317126	10/24/01	9/25/12	0.11	0.48	0.06	27	0	452.34	694	368.20	5
	M_SP59	8920	466357	4317186	10/24/01	6/6/04	0.31	0.69	0.12	5	1	548.66	859	445.90	5
	M_SP60	8801	462887	4316092	5/2/02	6/5/04	0.73	0.89	0.60	5	0	555.34	943	402.70	5
	M_SP61	9596	461881	4317168	5/2/02	6/5/04	0.32	0.37	0.25	5	0	316.12	593	36.10	5
	M_SP100	8975	463616	4316719	9/27/02	6/5/04	0.87	1.08	0.77	4	0	433.83	683	291.60	4
	M_SP103	8999	463271	4316302	5/21/03	6/5/04	1.21	1.51	0.94	3	0	499.40	706	376.60	3
	M_SP104	9052	463250	4316335	5/21/03	6/5/04	0.25	0.38	0.12	2	1	506.50	686	327.00	2
	M_SP105	8971	463233	4316280	5/21/03	6/5/04	0.79	0.95	0.62	3	0	479.97	696	362.90	3
	M_SP106	8997	462626	4316155	5/21/03	6/5/04	0.75	1.10	0.48	3	0	586.40	878	430.20	3
	M_SP01	8420	465615	4319979	6/19/01	9/6/12	0.47	1.11	0.16	29	0	562.23	851	434.70	9
	M_SP02	8335	466086	4319977	6/19/01	9/6/12	3.71	13.40	0.05	19	10	476.22	499	437.30	6
Price River Formation	M_SP18	8295	465794	4320892	6/22/01	9/6/12	0.31	0.77	0.06	27	2	889.71	1276	726.00	7
	M_SP39	8225	466990	4318775	8/30/01	9/6/12	1.22	4.66	0.22	28	0	748.38	1035	573.00	8
	M_SP45	8505	465156	4319780	10/4/01	6/3/04	1.64	2.23	0.67	6	0	724.23	977	369.40	6
Castlegate Formation	M_SP87	7922	465309	4322427	5/26/02	5/13/04	2.60	3.08	2.19	5	0	810.80	1277	627.00	5

Table 2. Field Monitoring Summary of Springs by Geologic Formation.

Formation	Castlegate	Price River	North Horn	Project Area
Number of Springs	1	5	27	33
Discharge (gpm)				
Number of Measurements	5	109	179	293
Maximum	3.08	13.40	61.40	61.40
Minimum	2.19	0.05	0.01	0.01
Median	2.52	0.54	0.56	0.57
Average	2.60	1.25	1.65	1.52
pH - Criteria: 6.5 - 9.0				
Number of Measurements	5	113	180	298
Maximum	8.39	8.49	8.72	8.72
Minimum	7.86	6.96	7.10	6.96
Median	8.14	7.43	7.72	7.62
Average	8.17	7.45	7.76	7.65
Dissolved Oxygen (mg/l) - Criteria : >3				
Number of Measurements	1	19	19	39
Maximum	6.60	7.39	7.69	7.69
Minimum	6.60	2.03	0.69	0.69
Median	6.60	4.82	6.03	5.21
Average	6.60	4.47	5.49	5.02
Water Temperature (Degree C) - Criteria : <27				
Number of Measurements	5	113	180	298
Maximum	6.10	16.50	27.60	27.60
Minimum	3.60	2.20	2.70	2.20
Median	5.20	6.30	7.25	6.70
Average	4.84	7.08	7.75	7.45
Specific Conductivity (uS/cm)				
Number of Measurements	5	36	140	181
Maximum	1,277	1,276	1,013	1,277
Minimum	627	369	36	36
Median	699	588	479	499
Average	811	680	528	566

Table 3. Water Quality Results - North Horn Formation Springs (including M_SP04, MSP07, M_SP08, and M_SP14).												
	Criteria (mg/l)					Concentration[a] (mg/l)						
Parameter Name	Criteria 1C	Criteria 2B	Criteria 3A	Criteria 3C	Criteria 4	Max	Min	Median	Mean	No. of Samples	No. of Detects	No. of Non-Detects
Acidity, as $CaCO_3$						38	7	17	19	19	19	
Aluminum (D)			0.75	0.75		0.05	0.03	0.05	0.04	19	5	14
Ammonia, as N			[b]	[b]		0.2	0.2	0.2	0.2	19	1	18
Arsenic (D)	0.01	0.1	0.340	0.340		0.1	0.0006	0.00125	0.01	19	18	1
Bicarbonate, as HC03-						580	340	530	516	27	27	
Boron (D)					0.75	0.11	0.06	0.07	0.08	19	17	2
Cadmium (D)	0.01		[c]0.002	[c]0.002	0.01	<0.005	<0.005	<0.005	<0.005	19	0	19
Calcium (D)						79	45	63	61	19	19	
Calcium (T)						83	48	64	65	27	27	
Carbonate, as CO_3						7	7	7	7	25	1	24
Chloride						60	2.1	29	30	27	27	
Copper (D)			[c]0.013	[c]0.013	0.2	<0.01	<0.01	<0.01	<0.01	19	0	19
Iron (D)			1	1		0.41	0.02	0.105	0.16	19	4	15
Iron (T)						2.5	0.03	0.36	0.7	24	17	7
Lead (D)	0.015		[c]0.065	[c]0.065	0.1	<0.07	<0.07	<0.07	<0.07	19	0	19
Magnesium (D)						43	24	37	35	19	19	
Magnesium (T)						43	24	38	35	27	27	
Manganese (D)						0.02	0.01	0.02	0.02	19	3	16
Manganese (T)						0.05	0.01	0.02	0.02	19	8	11
Molybdenum (D)						<0.02	<0.02	<0.02	<0.02	19	0	19
Nitrite, as N						<0.03	<0.03	<0.03	<0.03	19	0	19
NO2+NO3, as N						0.33	0.07	0.15	0.18	19	19	
Ortho-Phosphate						0.09	0.09	0.09	0.09	19	1	18
Potassium (D)						2.7	0.7	1.8	1.8	19	19	
Potassium (T)						6.7	0.7	2	2	22	20	2
Selenium (D)	0.05		0.0184	0.0184	0.05	0.1	0.0005	0.0026	0.01	18	17	1
Sodium (D)						130	15	87	92	19	19	
Sodium (T)						130	15	89	84	22	22	
Sulfate						44	6	24	23	27	27	
Total Alkalinity, as $CaCO_3$						480	279	440	419	27	27	
Total Anions						12	6.6	10	10	15	15	
Total Cations						12	6.7	10	10	15	15	
Total Dissolved Solids					[d]1,200 [e]2,000	651	238	501	486	27	27	
Total Hardness, as $CaCO_3$						340	230	310	296	19	19	
Zinc (D)			[c]0.12	[c]0.12		0.02	0.01	0.01	0.01	19	8	11

[a] Concentrations are based on sample measurements above detection limits (No. of Detects).

[b] Specific criterion varies with pH per Utah Administrative Code R317-2, Table 2.14.2.

[c] Specific criterion varies with hardness per Utah Administrative Code R317-2, Table 2.14.3b.

[d] For irrigation.

[e] For stock watering.

Table 4. Water Quality Results - Price River Formation Springs (including M_SP01, M_SP02, M_SP18, and M_SP39).												
	Criteria (mg/l)					Concentration[a] (mg/l)				No. of	No. of	No. of Non-
Parameter Name	Criteria 1C	Criteria 2B	Criteria 3A	Criteria 3C	Criteria 4	Max	Min	Median	Mean	Samples	Detects	Detects
Acidity, as $CaCO_3$						56	11	18	22	19	19	0
Aluminum (D)			0.75	0.75		0.06	0.04	0.05	0.05	19	4	15
Ammonia, as N			[b]	[b]		<0.02	<0.02	<0.02	<0.02	19	0	19
Arsenic (D)	0.01		0.340	0.340	0.1	0.1	0.0005	0.00095	0.01	19	18	1
Bicarbonate, as HC03-						552	344	473	464	31	31	0
Boron (D)					0.75	0.19	0.05	0.07	0.08	19	18	1
Cadmium (D)	0.01		[c]0.002	[c]0.002	0.01	<0.005	<0.005	<0.005	<0.005	19	0	19
Calcium (D)						130	73	80	90	19	19	0
Calcium (T)						140	73	81	90	27	27	0
Carbonate, as CO_3						<5	<5	<5	<5	31	0	31
Chloride						833	35	56	82	27	27	0
Copper (D)			[c]0.013	[c]0.013	0.2	<0.01	<0.01	<0.01	<0.01	19	0	19
Iron (D)			1	1		0.08	0.02	0.04	0.05	19	5	14
Iron (T)						37	0.02	0.15	3	26	12	14
Lead (D)	0.015		[c]0.065	[c]0.065	0.1	<0.07	<0.07	<0.07	<0.07	19	0	19
Magnesium (D)						50	33	42	43	19	19	0
Magnesium (T)						50	33	42	42	27	27	0
Manganese (D)						0.01	0.01	0.01	0.01	19	3	16
Manganese (T)						0.24	0.01	0.01	0.09	19	3	16
Molybdenum (D)						<0.02	<0.02	<0.02	<0.02	19	0	19
Nitrite, as N						<0.03	<0.03	<0.03	<0.03	19	0	19
NO2+NO3, as N						0.12	0.03	0.075	0.07	19	12	7
Ortho-Phosphate						<0.05	<0.05	<0.05	<0.05	19	0	19
Potassium (D)						5.2	1.7	2.1	2.7	19	19	0
Potassium (T)						6.6	1	2.1	3	21	21	0
Selenium (D)	0.05		0.0184	0.0184	0.05	0.0088	0.0019	0.0033	0.0039	19	17	2
Sodium (D)						96	43	82	70	19	19	0
Sodium (T)						100	43	80	71	21	21	0
Sulfate						330	26	65	101	27	27	0
Total Alkalinity, as $CaCO_3$						453	282	385	375	31	31	0
Total Anions						15	9.1	10.5	11	16	16	0
Total Cations						14	9.1	10.5	11	16	16	0
Total Dissolved Solids					[d]1,200 [e]2,000	1214	449	553	618	27	27	0
Total Hardness, as $CaCO_3$						510	330	390	400	19	19	0
Zinc (D)			[c]0.12	[c]0.12		0.13	0.01	0.01	0.03	19	13	6

[a] Concentrations are based on sample measurements above detection limits (No. of Detects).

[b] Specific criterion varies with pH per Utah Administrative Code R317-2, Table 2.14.2.

[c] Specific criterion varies with hardness per Utah Administrative Code R317-2, Table 2.14.3b.

[d] For irrigation.

[e] For stock watering.

Table 5. Value of springs in the Greens Hollow Tract project area.					
Spring Site ID	< 500 ft to Wetland	< 25 ft to Wetland	< 500 ft to Riparian	Developed	Value
M_SP01			X	X	High
M_SP02		X	X	X	High
M_SP03			X		Moderate
M_SP04			X		Moderate
M_SP05			X		Moderate
M_SP06			X		Moderate
M_SP07	X		X		Moderate
M_SP08		X		X	High
M_SP09		X			High
M_SP12		X	X		High
M_SP13		X	X		High
M_SP14		X		X	High
M_SP15			X		Moderate
M_SP18				X	High
M_SP19			X		Moderate
M_SP20		X	X		High
M_SP21			X		Moderate
M_SP39		X	X	X	High
M_SP40			X		Moderate
M_SP41		X	X		High
M_SP43		X			High
M_SP44		X			High
M_SP45			X		Moderate
M_SP53				X	Moderate
M_SP59					Unknown
M_SP60			X		Moderate
M_SP61		X	X		High
M_SP87			X		Moderate
M_SP100			X		Moderate
M _SP103					Unknown
M _SP104					Unknown
M _SP105					Unknown
M _SP106			X		Moderate

Table 6. Field Monitoring Summary for Greens Hollow Tract Surface Water Monitoring Stations.

Station ID	M_STR1	M_STR2	M_STR3	M_STR4	M_STR5	M_STR6	M_STR7	M_STR8	M_STR9	M_STR10
Location	Greens Canyon	Greens Canyon	Lower Cowboy Creek	Upper Cowboy Creek	Cowboy Creek	Greens Hollow	Unnamed Drainage	South Fork Muddy Ck.	S. Fork of N. Fork Quitchupah Ck.	Upper N. Fork Quitchupah Ck.
Start	6/6/01	8/7/02	6/6/01	6/7/01	8/8/02	6/7/01	9/25/02	9/26/02	10/5/79	10/5/79
End	5/10/04	5/10/04	5/10/04	9/25/12	5/11/04	5/11/04	5/13/04	5/13/04	9/12/12	9/26/12
# Visits	16	8	16	37	8	16	6	6	94	98
Flow (GPM)										
# NOF	13	1	2	21	1	5	6	0	1	0
# Samples	3	7	14	16	7	11	0	6	90	91
Maximum	672	460	491	717	598	27	0	15,644	1,116	6,032
Minimum	9.7	1.2	0.5	0.7	1.4	1.9	0.0	967.7	0.1	0.2
Median	50.1	2.9	2.6	12.6	2.0	5.7	0.0	2,767.0	112.2	188.5
Average	243.9	78.1	44.2	69.2	95.6	10.0	0.0	5,225.5	196.5	715.9
pH - Criteria: 6.5-9.0										
# Samples	3	7	13	15	7	10	0	6	90	91
Maximum	8.92	8.84	8.73	8.87	8.82	8.77	0.00	8.90	8.89	9.20
Minimum	8.48	7.97	7.72	8.48	6.50	7.92	0.00	8.69	7.10	7.30
Median	8.61	8.25	8.01	8.72	8.47	8.52	0.00	8.73	8.34	8.40
Average	8.7	8.3	8.1	8.7	8.3	8.5	0.0	8.8	8.3	8.3
Dissolved Oxygen (mg/l) - Criteria >4 (or >8 when early life stages are present)										
# Samples	3	7	13	14	7	10	0	6	43	44
Maximum	8.65	11.19	9.70	10.40	9.04	8.73	0.00	13.66	10.60	10.60
Minimum	7.53	5.84	3.58	5.23	7.23	3.14	0.00	7.51	5.00	5.65
Median	8.6	8.4	5.6	7.9	8.2	7.1	0.0	9.5	7.4	7.7
Average	8.3	8.3	6.1	7.8	8.2	6.8	0.0	9.9	7.5	7.8
Water Temperature (Degree C) - Criteria: <20										
# Samples	3	7	13	15	7	10	0	6	90	91
Maximum	13.6	14.9	13.0	21.2	10.3	23.3	0.0	16.2	22.8	22.5
Minimum	0.7	0.8	3.6	0.3	6.0	2.7	0.0	1.0	0.3	0.0
Median	9.9	9.3	8.4	12.1	9.5	12.1	0.0	4.9	14.7	12.5
Average	8.1	8.8	8.4	12.6	8.4	12.8	0.0	6.6	13.5	12.5
Specific Conductivity (uS/cm)										
# Samples	2	7	13	7	7	10	0	6	58	63
Maximum	567	722	659	869	616	822	0	371	1,300	1,384
Minimum	448	416	202	386	346	439	0	65	398	294
Median	507.7	509.0	404.7	514.0	445.8	572.0	0.0	240.4	710.0	490.0
Average	507.7	554.5	434.6	582.1	475.9	615.3	0.0	250.0	729.6	500.8
Turbidity (ntu)										
# Samples	3	7	13	7	6	10	0	5	50	53
Maximum	19.6	39.9	51.4	76.3	22.5	96.3	0.0	6.8	640.0	1125.0
Minimum	7.5	0.7	0.0	0.0	1.4	8.3	0.0	1.5	1.7	0.9
Median	18.4	3.7	2.8	4.7	4.0	21.4	0.0	2.2	29.7	24.0
Average	15.2	14.0	12.4	15.4	8.5	36.7	0.0	3.5	50.6	143.4

Table 7. Flood Flow Analysis for Greens Hollow Drainages									
Drainage Basin Location	**Area (ares)**	**Area (sq Mi)**	**Mean Elevation (ft. msl)**	**Q2**	**Q5**	**Q10**	**Q25**	**Q50**	**Q100**
Greens Canyon @ STR-1	5,859	9.15	8720	199	443	656	1,017	1,351	1,716
Greens Hollow @ STR-6	1,573	2.46	8786	102	243	371	592	800	1,033
Cowboy Creek @ STR-3	3,580	5.59	8795	154	351	526	823	1,101	1,406
Unnamed Tributary @ STR-7	555	0.87	8296	64	164	258	424	582	764
NF. Quitchupah @ Sufco 042	15,373	24.02	8382	336	718	1,045	1,591	2,092	2,628
Muddy Creek @ Sufco 405	46,372	72.46	9254	528	1,039	1,455	2,143	2,763	3,405
Muddy Creek @ USGS 09330500	69,639	108.8	8879	676	1,315	1,832	2,685	3,451	4,239
Frequency Analysis Estimate for Muddy Creek @ USGS 09330500	69,639	108.8		441	959	1,502	2,495	3,523	4,866

Table 8. Water Quality Results (2002-2004) - Stream Monitoring Station M_STR8, South Fork of Muddy Creek.

Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					na	na	na	BDL	6	0	6
Aluminum (D)			0.75_a		0.04	0.03	0.035	0.04	6	2	4
Ammonia, as N			$_b$		na	na	na	BDL	6	0	6
Arsenic (D)	0.01		0.15	0.1	0.0011	0.0009	0.001	0.001	6	4	2
Bicarbonate, as HC03-					280	230	255	258	6	6	0
Boron (D)				0.75	na	na	na	BDL	6	0	6
Cadmium (D)	0.01		2_c	0.01	na	na	na	BDL	6	0	6
Calcium (D)					54	43	47.5	49	6	6	0
Calcium (T)					63	46	48	52	3	3	0
Carbonate, as CO3--					9	2	7	6	6	5	1
Chloride					3.1	1.4	1.95	2.1	6	6	0
Chromium (D)	0.05		0.016	0.1	na	na	na	na	0	0	0
Copper (D)			0.013_c	0.2	na	na	na	BDL	6	0	6
Cyanide (D)			0.0052		na	na	na	na	0	0	0
Hydroxide					na	na	na	BDL	2	0	2
Iron (D)			1		na	na	na	BDL	6	0	6
Iron (T)					0.45	0.02	0.11	0.19	6	6	0
Lead (D)	0.015		0.065_c	0.1	na	na	na	BDL	6	0	6
Magnesium (D)					27	22	24.5	25	6	6	0
Magnesium (T)					28	25	25	26	3	3	0
Manganese (D)					na	na	na	BDL	6	0	6
Manganese (T)					0.02	0.01	0.02	0.02	6	3	3
Mercury (D)	0.002		0.0024		na	na	na	na	0	0	0
Molybdenum (D)					na	na	na	BDL	6	0	6
Nickel (D)			0.468_c		na	na	na	na	0	0	0
Nitrite, as N					na	na	na	BDL	6	0	6
NO2+NO3, as N					0.8	0.54	0.675	0.7	6	6	0
Ortho-Phosphate					na	na	na	BDL	6	0	6
Potassium (D)					0.7	0.6	0.6	0.6	6	6	0
Potassium (T)					na	na	na	na	0	0	0
Selenium (D)	0.05	0.05	0.0184		0.0008	0.0006	0.00065	0.0007	6	4	2
Silver (D)	0.05		0.0016_c		na	na	na	na	0	0	0
Sodium (D)					12	5.5	8.95	9	6	6	0
Sodium (T)					na	na	na	na	0	0	0
Sulfate					12	6.6	8.85	9	6	6	0
Total Alkalinity, as CaCO3					230	200	221	219	6	6	0
Total Anions					5	4.2	4.6	5	5	5	0
Total Cations					5.2	4.4	4.9	4.9	5	5	0
Total Dissolved Solids				$1{,}200_d$ $2{,}000_e$	270	208	238	238	6	6	0
Total Hardness, as CaCO3					230	210	220	222	6	6	0
Total Phosphorus		0.05	0.05		na	na	na	na	0	0	0
Total Suspended Solids					44	5	12	18	6	6	0
Zinc (D)			0.120_c		0.01	0.01	0.01	0.01	6	2	4

a = Criterion varies with pH and hardness.
b = Criterion varies with pH and temperature.
c = Criterion varies with hardness.
d = For irrigation.
e = For stock watering.

Table 9. Water Quality Results (2001-2004) - Stream Monitoring Station M_STR1, Lower Greens Canyon.

Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					na	na	na	BDL	2	0	2
Aluminum (D)			0.75_a		0.03	0.03	0.03	0.03	3	1	2
Ammonia, as N			$_b$		na	na	na	BDL	2	0	2
Arsenic (D)	0.01		0.15	0.1	0.1	0.0008	0.001	0.03	3	3	0
Bicarbonate, as HC03-					350	260	349	320	3	3	0
Boron (D)				0.75	na	na	na	BDL	2	0	2
Cadmium (D)	0.01		2_c	0.01	na	na	na	BDL	3	0	3
Calcium (D)					50	45	47.5	48	2	2	0
Calcium (T)					53	43	50	49	3	3	0
Carbonate, as CO3--					18	5	7	10	3	3	0
Chloride					24	7.4	18	16	3	3	0
Chromium (D)	0.05		0.016	0.1	0.0034	0.0034	0.0034	0.0034	3	1	2
Copper (D)			0.013_c	0.2	0.0013	0.0013	0.0013	0.0013	3	1	2
Cyanide (D)			0.0052		0.002	0.002	0.002	0.002	3	1	2
Hydroxide					na	na	na	BDL	1	0	1
Iron (D)			1		na	na	na	BDL	2	0	2
Iron (T)					0.57	0.15	0.5	0.41	3	3	0
Lead (D)	0.015		0.065_c	0.1	na	na	na	BDL	3	0	3
Magnesium (D)					27	19	na	23	2	2	0
Magnesium (T)					35	19	32	29	3	3	0
Manganese (D)					na	na	na	BDL	2	0	2
Manganese (T)					0.02	0.02	0.02	0.02	2	1	1
Mercury (D)	0.002		0.0024		0.0002	0.0002	0.0002	0.0002	3	2	1
Molybdenum (D)					na	na	na	BDL	2	0	2
Nickel (D)			0.468_c		0.0016	0.0016	0.0016	0.002	3	1	2
Nitrite, as N					na	na	na	BDL	3	0	3
NO2+NO3, as N					na	na	na	BDL	3	0	3
Ortho-Phosphate					0.07	0.07	0.07	0.07	3	1	2
Potassium (D)					2.3	1.8	2.05	2.1	2	2	0
Potassium (T)					3.1	2	2.7	3	3	3	0
Selenium (D)	0.05	0.05	0.0184		0.001	0.0005	0.00075	0.00075	3	2	1
Silver (D)	0.05		0.0016_c		na	na	na	BDL	3	0	3
Sodium (D)					42	32	37	37	2	2	0
Sodium (T)					54	30	48	44	3	3	0
Sulfate					34	13	34	27	3	3	0
Total Alkalinity, as CaCO3					298	250	290	279	3	3	0
Total Anions					7.1	5.3	6.2	6.2	2	2	0
Total Cations					6.3	5.5	5.9	5.9	2	2	0
Total Dissolved Solids				$1{,}200_d$ $2{,}000_e$	570	378	401	450	3	3	0
Total Hardness, as CaCO3					220	200	210	210	2	2	0
Total Phosphorus		0.05	0.05		0.05	0.03	0.05	0.04	3	3	0
Total Suspended Solids					15	7	11	11	2	2	0
Zinc (D)			0.120_c		0.02	0.02	0.02	0.02	3	1	2

a = Criterion varies with pH and hardness.
b = Criterion varies with pH and temperature.
c = Criterion varies with hardness.
d = For irrigation.
e = For stock watering.

Table 10. Water Quality Results (2002-2004) - Stream Monitoring Station M_STR2, Greens Canyon.

Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					na	na	na	BDL	6	0	6
Aluminum (D)			0.75_a		0.06	0.05	0.04	0.06	7	2	5
Ammonia, as N			$_b$		na	na	na	BDL	6	0	6
Arsenic (D)	0.01		0.15	0.1	0.0016	0.0009	0.001	0.001	7	4	3
Bicarbonate, as HC03-					411	280	356	355	7	7	0
Boron (D)				0.75	0.07	0.05	0.055	0.06	6	4	2
Cadmium (D)	0.01		2_c	0.01	na	na	na	BDL	7	0	7
Calcium (D)					77	48	58	64	6	6	0
Calcium (T)					77	58	56.5	67	7	7	0
Carbonate, as CO3--					14	5	6	8	7	3	4
Chloride					38	5.3	26.4	25	7	7	0
Chromium (D)	0.05		0.016	0.1	na	na	na	BDL	6	0	6
Copper (D)			0.013_c	0.2	na	na	na	BDL	7	0	7
Cyanide (D)			0.0052		na	na	na	BDL	6	0	6
Hydroxide					na	na	na	BDL	2	0	2
Iron (D)			1		na	na	na	BDL	6	0	6
Iron (T)					1.6	0.05	0.41	0.6	7	6	1
Lead (D)	0.015		0.065_c	0.1	na	na	na	BDL	7	0	7
Magnesium (D)					53	18	33	38	6	6	0
Magnesium (T)					52	20	35	39	7	7	0
Manganese (D)					0.02	0.02	0.015	0.02	6	1	5
Manganese (T)					0.07	0.01	0.02	0.04	6	4	2
Mercury (D)	0.002		0.0024		na	na	na	BDL	6	0	6
Molybdenum (D)					na	na	na	BDL	6	0	6
Nickel (D)			0.468_c		na	na	na	BDL	6	0	6
Nitrite, as N					na	na	na	BDL	6	0	6
NO2+NO3, as N					0.11	0.11	0.085	0.11	7	1	6
Ortho-Phosphate					0.08	0.08	0.07	0.08	7	1	6
Potassium (D)					4.1	2.4	2.7	3.1	6	6	0
Potassium (T)					4.8	2.7	2.75	3.6	6	6	0
Selenium (D)	0.05	0.05	0.0184		0.0021	0.0006	0.00135	0.0012	7	5	2
Silver (D)	0.05		0.0016_c		na	na	na	BDL	6	0	6
Sodium (D)					54	28	41	44	6	6	0
Sodium (T)					52	28	41.5	44	6	6	0
Sulfate					140	9.1	41.5	74	7	7	0
Total Alkalinity, as CaCO3					337	230	292.5	295	7	7	0
Total Anions					10	4.9	7.25	8	5	5	0
Total Cations					11	5.1	7.3	8	5	5	0
Total Dissolved Solids				$1{,}200_d$ $2{,}000_e$	531	271	394.5	438	7	7	0
Total Hardness, as CaCO3					410	190	280	315	6	6	0
Total Phosphorus		0.05	0.05		0.12	0.03	0.05	0.07	6	6	0
Total Suspended Solids					83	9	41	33	6	5	1
Zinc (D)			0.120_c		0.02	0.01	0.02	0.01	7	4	3

a = Criterion varies with pH and hardness.
b = Criterion varies with pH and temperature.
c = Criterion varies with hardness.
d = For irrigation.
e = For stock watering.

Table 11. Water Quality Results (2001-2004) - Stream Monitoring Station M_STR3, Lower Cowboy Creek.

Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					6	6	6	6	5	1	4
Aluminum (D)			0.75_a		0.05	0.03	0.04	0.04	12	5	7
Ammonia, as N			b		na	na	na	BDL	5	0	5
Arsenic (D)	0.01		0.15	0.1	0.1	0.0008	0.001	0.01	12	9	3
Bicarbonate, as HC03-					373	250	356	346	12	12	0
Boron (D)				0.75	0.07	0.05	0.055	0.06	5	4	1
Cadmium (D)	0.01		2_c	0.01	na	na	na	BDL	12	0	12
Calcium (D)					62	42	58	55	5	5	0
Calcium (T)					63	41	56.5	56	12	12	0
Carbonate, as CO3--					6	6	6	6	12	2	10
Chloride					30	4.5	26.4	24	12	12	0
Chromium (D)	0.05		0.016	0.1	0.0037	0.001	0.0036	0.003	12	3	9
Copper (D)			0.013_c	0.2	0.001	0.0007	0.0008	0.001	12	3	9
Cyanide (D)			0.0052		0.005	0.002	0.003	0.003	12	3	9
Hydroxide					na	na	na	BDL	2	0	2
Iron (D)			1		0.02	0.02	0.02	0.02	5	1	4
Iron (T)					1.7	0.1	0.41	0.6	12	8	4
Lead (D)	0.015		0.065_c	0.1	na	na	na	BDL	12	0	12
Magnesium (D)					39	14	33	30	5	5	0
Magnesium (T)					39	18	35	34	12	12	0
Manganese (D)					0.02	0.01	0.015	0.02	5	2	3
Manganese (T)					0.06	0.02	0.02	0.03	7	5	2
Mercury (D)	0.002		0.0024		na	na	na	BDL	12	0	12
Molybdenum (D)					na	na	na	BDL	5	0	5
Nickel (D)			0.468_c		0.01	0.0013	0.0022	0.004	12	5	7
Nitrite, as N					na	na	na	BDL	7	0	7
NO2+NO3, as N					0.31	0.03	0.085	0.12	12	6	6
Ortho-Phosphate					0.07	0.07	0.07	0.07	7	1	6
Potassium (D)					3.4	2.1	2.7	2.6	5	5	0
Potassium (T)					4.5	2	2.75	3	12	12	0
Selenium (D)	0.05	0.05	0.0184		0.0027	0.0005	0.00135	0.0014	12	10	2
Silver (D)	0.05		0.0016_c		na	na	na	BDL	12	0	12
Sodium (D)					50	23	41	39	5	5	0
Sodium (T)					57	22	41.5	42	12	12	0
Sulfate					55	7.4	41.5	39	12	12	0
Total Alkalinity, as CaCO3					306	210	292.5	286	12	12	0
Total Anions					8	4.3	7.25	7	4	4	0
Total Cations					8.1	4.3	7.3	6.8	4	4	0
Total Dissolved Solids				$1{,}200_d$ $2{,}000_e$	418	247	394.5	382	12	12	0
Total Hardness, as CaCO3					310	160	280	258	5	5	0
Total Phosphorus		0.05	0.05		0.13	0.03	0.05	0.06	12	9	3
Total Suspended Solids					113	7	41	42	7	7	0
Zinc (D)			0.120_c		0.04	0.01	0.02	0.02	12	5	7

a = Criterion varies with pH and hardness.
b = Criterion varies with pH and temperature.
c = Criterion varies with hardness.
d = For irrigation.
e = For stock watering.

Table 12. Water Quality Results (2001-2004) - Stream Monitoring Station M_STR4, Upper Cowboy Creek.

Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					na	na	na	BDL	2	0	2
Aluminum (D)			0.75_a		0.06	0.03	0.045	0.05	6	2	4
Ammonia, as N			b		na	na	na	BDL	2	0	2
Arsenic (D)	0.01		0.15	0.1	0.1	0.0008	0.00125	0.03	6	4	2
Bicarbonate, as HC03-					431	280	360.5	364	6	6	0
Boron (D)				0.75	na	na	na	BDL	2	0	2
Cadmium (D)	0.01		2_c	0.01	na	na	na	BDL	6	0	6
Calcium (D)					52	50	51	51	2	2	0
Calcium (T)					60	34	55.5	50	6	6	0
Carbonate, as CO3--					17	5	12	12	6	6	0
Chloride					60	5.6	29	31	6	6	0
Chromium (D)	0.05		0.016	0.1	0.0039	0.0039	0.0039	0.0039	6	1	5
Copper (D)			0.013_c	0.2	0.0011	0.0011	0.0011	0.0011	6	1	5
Cyanide (D)			0.0052		0.004	0.004	0.004	0.004	6	1	5
Hydroxide					na	na	na	BDL	1	0	1
Iron (D)			1		na	na	na	BDL	2	0	2
Iron (T)					0.57	0.18	0.29	0.33	6	5	1
Lead (D)	0.015		0.065_c	0.1	na	na	na	BDL	6	0	6
Magnesium (D)					27	18	22.5	23	2	2	0
Magnesium (T)					43	19	37.5	35	6	6	0
Manganese (D)					0.01	0.01	0.01	0.01	2	2	0
Manganese (T)					0.03	0.02	0.025	0.03	3	2	1
Mercury (D)	0.002		0.0024		na	na	na	BDL	6	0	6
Molybdenum (D)					na	na	na	BDL	2	0	2
Nickel (D)			0.468_c		0.01	0.0016	0.0019	0.005	6	3	3
Nitrite, as N					na	na	na	BDL	3	0	3
NO2+NO3, as N					0.05	0.05	0.05	0.05	6	1	5
Ortho-Phosphate					na	na	na	BDL	4	0	4
Potassium (D)					2	1.6	1.8	2	2	2	0
Potassium (T)					3	1	2.15	2	6	6	0
Selenium (D)	0.05	0.05	0.0184		0.0016	0.0006	0.00095	0.0010	6	4	2
Silver (D)	0.05		0.0016_c		na	na	na	BDL	6	0	6
Sodium (D)					49	27	38	38	2	2	0
Sodium (T)					87	25	65.5	63	6	6	0
Sulfate					71	9.3	30	38	6	6	0
Total Alkalinity, as CaCO3					372	240	317.5	318	6	6	0
Total Anions					7.1	5.2	6.15	6.2	2	2	0
Total Cations					6.9	5.3	6.1	6.1	2	2	0
Total Dissolved Solids				$1{,}200_d$ $2{,}000_e$	548	280	414	420	6	6	0
Total Hardness, as CaCO3					240	200	220	220	2	2	0
Total Phosphorus		0.05	0.05		0.1	0.01	0.035	0.0	6	4	2
Total Suspended Solids					21	17	19	19	2	2	0
Zinc (D)			0.120_c		0.01	0.01	0.01	0.01	6	2	4

a = Criterion varies with pH and hardness.
b = Criterion varies with pH and temperature.
c = Criterion varies with hardness.
d = For irrigation.
e = For stock watering.

Table 13. Water Quality Results (2002-2004) - Stream Monitoring Station M_STR5, Cowboy Creek.

Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					na	na	na	BDL	6	0	6
Aluminum (D)			0.75_a		0.05	0.03	0.04	0.04	8	3	5
Ammonia, as N			$_b$		na	na	na	BDL	6	0	6
Arsenic (D)	0.01		0.15	0.1	0.0009	0.0006	0.0008	0.0008	8	5	3
Bicarbonate, as HC03-					360	290	318	331	8	8	0
Boron (D)				0.75	0.06	0.05	0.05	0.05	6	4	2
Cadmium (D)	0.01		2_c	0.01	na	na	na	BDL	8	0	8
Calcium (D)					55	51	53	53	6	6	0
Calcium (T)					60	51	54.5	55	8	8	0
Carbonate, as CO3--					10	6	7	8	8	5	3
Chloride					29	5.6	24	22	8	8	0
Chromium (D)	0.05		0.016	0.1	0.0034	0.0034	0.0034	0.0034	7	1	6
Copper (D)			0.013_c	0.2	na	na	na	BDL	8	0	8
Cyanide (D)			0.0052		0.002	0.002	0.002	0.002	6	0	6
Hydroxide					na	na	na	BDL	2	0	2
Iron (D)			1		na	na	na	BDL	6	0	6
Iron (T)					0.68	0.02	0.13	0.29	8	7	1
Lead (D)	0.015		0.065_c	0.1	na	na	na	BDL	8	0	8
Magnesium (D)					36	18	34.5	31	6	6	0
Magnesium (T)					36	19	34.5	33	8	8	0
Manganese (D)					na	na	na	BDL	6	0	6
Manganese (T)					0.02	0.01	0.02	0.02	7	4	3
Mercury (D)	0.002		0.0024		na	na	na	BDL	6	0	6
Mercury (T)					na	na	na	BDL	1	0	1
Molybdenum (D)					na	na	na	BDL	6	0	6
Nickel (D)			0.468_c		0.01	0.0069	0.01	0.01	7	3	4
Nitrite, as N					na	na	na	BDL	6	0	6
NO2+NO3, as N					0.27	0.03	0.14	0.14	8	6	2
Ortho-Phosphate					na	na	na	BDL	7	0	7
Potassium (D)					2.2	1.7	2	2	6	6	0
Potassium (T)					2.6	2	2.1	2.2	7	7	0
Selenium (D)	0.05	0.05	0.0184		0.0035	0.0006	0.002	0.002	8	5	3
Silver (D)	0.05		0.0016_c		na	na	na	BDL	7	0	7
Sodium (D)					52	27	32.5	35	6	6	0
Sodium (T)					59	25	33	36	7	7	0
Sulfate					39	9.1	35	31	8	8	0
Total Alkalinity, as CaCO3					300	240	268.5	274	8	8	0
Total Anions					7.4	5.1	7.1	6.8	5	5	0
Total Cations					7.2	5.3	7	7	5	5	0
Total Dissolved Solids				$1,200_d$ $2,000_e$	405	290	348.5	350	8	8	0
Total Hardness, as CaCO3					300	200	275	263	6	6	0
Total Phosphorus		0.05	0.05		0.05	0.01	0.02	0.03	7	6	1
Total Suspended Solids					400	6	21	84	6	6	0
Zinc (D)			0.120_c		0.08	0.01	0.01	0.03	8	5	3

a = Criterion varies with pH and hardness.
b = Criterion varies with pH and temperature.
c = Criterion varies with hardness.
d = For irrigation.
e = For stock watering.

Table 14. Water Quality Results (2001-2004) - Stream Monitoring Station M_STR6, Greens Hollow.

Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					na	na	na	BDL	2	0	2
Aluminum (D)			0.75_a		0.05	0.03	0.045	0.04	9	4	5
Ammonia, as N			$_b$		na	na	na	BDL	2	0	2
Arsenic (D)	0.01		0.15	0.1	0.0025	0.0015	0.0016	0.0019	9	5	4
Bicarbonate, as HC03-					538	381	430	439	9	9	0
Boron (D)				0.75	0.06	0.05	0.055	0.06	2	2	0
Cadmium (D)	0.01		2_c	0.01	na	na	na	BDL	9	0	9
Calcium (D)					55	55	55	55	2	2	0
Calcium (T)					66	37	58	56	9	9	0
Carbonate, as CO3--					17	2	9.5	10	9	6	3
Chloride					57.9	21	40	41	9	9	0
Chromium (D)	0.05		0.016	0.1	0.006	0.0045	0.0051	0.005	9	3	6
Copper (D)			0.013_c	0.2	0.0019	0.0014	0.00165	0.002	9	2	7
Cyanide (D)			0.0052		0.015	0.008	0.0115	0.01	9	2	7
Hydroxide					na	na	na	BDL	1	0	1
Iron (D)			1		na	na	na	BDL	2	0	2
Iron (T)					1.7	0.3	0.54	0.8	9	9	0
Lead (D)	0.015		0.065_c	0.1	na	na	na	BDL	9	0	9
Magnesium (D)					31	25	28	28	2	2	0
Magnesium (T)					42	25	36	35	9	9	0
Manganese (D)					0.01	0.01	0.01	0.01	2	1	1
Manganese (T)					0.04	0.03	0.035	0.04	3	2	1
Mercury (D)	0.002		0.0024		na	na	na	BDL	9	0	9
Molybdenum (D)					na	na	na	BDL	2	0	2
Nickel (D)			0.468_c		0.01	0.0014	0.0027	0.004	9	5	4
Nitrite, as N					na	na	na	BDL	4	0	4
NO2+NO3, as N					0.08	0.04	0.05	0.06	9	3	6
Ortho-Phosphate					na	na	na	BDL	4	0	4
Potassium (D)					2.8	2.7	2.75	2.8	2	2	0
Potassium (T)					9	2	3.2	4	9	9	0
Selenium (D)	0.05	0.05	0.0184		0.0014	0.0008	0.0009	0.0010	9	7	2
Silver (D)	0.05		0.0016_c		na	na	na	BDL	9	0	9
Sodium (D)					85	80	82.5	83	2	2	0
Sodium (T)					101	77	86	87	9	9	0
Sulfate					53	21	41	40	9	9	0
Total Alkalinity, as CaCO3					441	341	373	373	9	9	0
Total Anions					8.8	8.3	8.55	8.6	2	2	0
Total Cations					8.8	8.6	8.7	8.7	2	2	0
Total Dissolved Solids				$1,200_d$ $2,000_e$	595	451	515	508	9	9	0
Total Hardness, as CaCO3					260	240	250	250	2	2	0
Total Phosphorus		0.05	0.05		0.14	0.03	0.06	0.07	9	8	1
Total Suspended Solids					42	21	25	29	3	3	0
Zinc (D)			0.120_c		0.02	0.01	0.01	0.01	9	4	5

a = Criterion varies with pH and hardness.
b = Criterion varies with pH and temperature.
c = Criterion varies with hardness.
d = For irrigation.
e = For stock watering.

Table 15. Water Quality Results (1980-2012) - Stream Monitoring Station M_STR9, South Fork of North Fork Quitchupah Creek.

Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					34.2	0.01	2.5	8.4	15	13	2
Ammonia, as N			a		na	na	na	BDL	2	0	2
Arsenic (T)					0.003	0.002	0.003	0.003	3	2	1
Bicarbonate, as HC03-					549	128	306.70	320	79	79	0
Boron (T)					1.08	0.04	0.106	0.18	48	44	4
Cadmium (T)					na	na	na	BDL	3	0	3
Calcium (D)					94.7	49	56.0	59	44	44	0
Calcium (T)					156	22.4	63.03	65	51	51	0
Carbonate, as CO3--					79	0.01	9	14	60	28	32
Chloride					45	2.9	10.2	15	92	92	0
Chromium (T)					na	na	na	BDL	2	0	2
Copper (T)					0.012	0.01	0.011	0.01	2	2	0
Hydroxide					0.1	0.01	0.1	0.1	43	14	29
Iron (D)			1		0.51	0.006	0.03	0.08	93	37	56
Iron (T)					24.6	0.018	0.71	1.4	93	91	2
Lead (T)					0.003	0.001	0.002	0.002	2	2	0
Magnesium (D)					56.4	30	33	34	44	44	0
Magnesium (T)					108	2.88	34.1	35	51	50	1
Manganese (D)					0.14	0.002	0.02	0.03	89	49	40
Manganese (T)					0.73	0.005	0.05	0.07	93	75	18
Mercury (T)					0.1	0.1	0.1	0.1	2	1	1
Nickel (T)					na	na	na	BDL	2	0	2
Nitrite, as N					na	na	na	BDL	3	0	3
NO2+NO3, as N					0.08	0.08	0.08	0.08	8	1	7
Ortho-Phosphate					0.7	0.01	0.03	0.1	11	11	0
Potassium (D)					6.47	0.93	1.68	1.96	43	42	1
Potassium (T)					4	1	3.5	3	13	13	0
Selenium (T)					na	na	na	BDL	3	0	3
Silver (T)					na	na	na	BDL	2	0	2
Sodium (D)					110	10.9	19.1	28	44	44	0
Sodium (T)					100	10.8	46.1	49	50	50	0
Sulfate					405	18	90.0	95	91	91	0
Total Alkalinity, as CaCO3					450	184	251.4	269	89	89	0
Total Anions					14.5	4.5	6.50	7.1	49	49	0
Total Cations					14.3	4.7	6.3	7.1	49	49	0
Total Dissolved Solids				$1,200_b$ $2,000_c$	850	269	401.0	428	91	91	0
Total Hardness, as CaCO3					610	203	294	307	77	77	0
Total Phosphorus		0.05	0.05		1.12	0.014	0.1	0.2	18	18	0
Total Suspended Solids					13	13	13	13	1	1	0
Zinc (T)					0.003	0.003	0.003	0.003	2	1	1

a = Criterion varies with hardness. c = For stock watering.

b = For irrigation

Table 16. Water Quality Results (1979-2012) - Stream Monitoring Station M_STR10, Upper North Fork Quitchupah Creek.

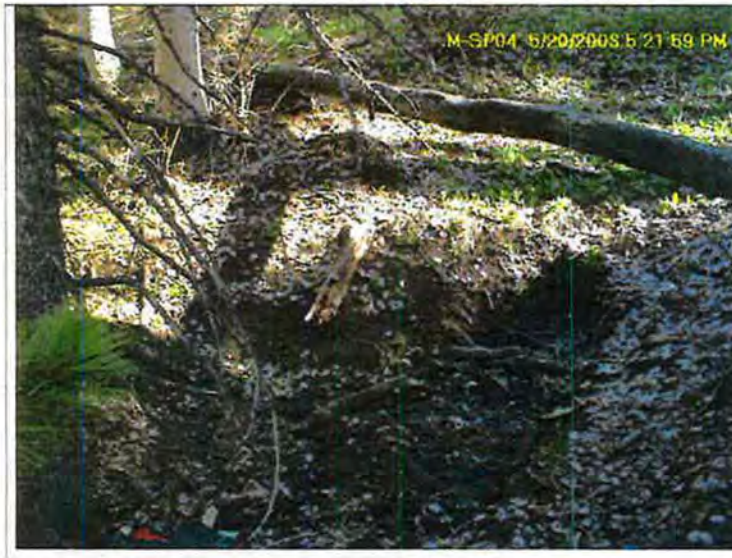
Parameter Name	Criteria (mg/l)				Detected Values (mg/l)				# Samples	# Detects	# BDL
	1C	2B	3A	4	Max	Min	Median	Mean			
Acidity, as CaCO3					18	0	1.2	4	15	13	2
Ammonia, as N			a		na	na	na	BDL	2	0	2
Arsenic (T)					0.001	0.001	0.001	0.001	4	2	2
Bicarbonate, as HC03-					493	156	246.6	257	81	81	0
Boron (T)					0.82	0.01	0.10	0.15	48	40	8
Cadmium (T)					na	na	na	BDL	4	0	4
Calcium (D)					66	37	50	49	45	45	0
Calcium (T)					144	20.5	54.80	57	52	52	0
Carbonate, as CO3--					21	0	8	9	62	23	39
Chloride					86	1	7	9	96	94	2
Chromium (T)					na	na	na	BDL	2	0	2
Copper (T)					0.01	0.01	0.01	0.01	2	2	0
Hardness, (calc)					0.2	0	0.1	0.1	45	16	29
Iron (D)			1		1	0.008	0.04	0.14	94	31	63
Iron (T)					29.6	0.02	0.4	2.1	95	82	13
Lead (T)					0.005	0.004	0.0045	0.005	2	2	0
Magnesium (D)					26	12.1	17.0	18	45	45	0
Magnesium (T)					240	0.48	21.33	28	52	51	1
Manganese (D)					0.2	0.002	0.01	0.03	91	40	51
Manganese (T)					1.46	0.002	0.02	0.09	94	66	28
Mercury (T)					na	na	na	BDL	2	0	2
Nickel (T)					na	na	na	BDL	2	0	2
Nitrite, as N					na	na	na	BDL	5	0	5
NO2+NO3, as N					na	na	na	BDL	8	0	8
Ortho-Phosphate					0.23	0.01	0.025	0.06	10	8	2
Potassium (D)					1.65	0.48	0.83	0.90	44	34	10
Potassium (T)					9.1	0.67	2	3	14	13	1
Selenium (T)					na	na	na	BDL	4	0	4
Silver (T)					na	na	na	BDL	2	0	2
Sodium (D)					39	4.80	18.60	18	45	45	0
Sodium (T)					163.9	6	22.32	30	52	52	0
Sulfate					475	9	25.0	36	96	96	0
Total Alkalinity, as CaCO3					404	165	206.0	215	91	91	0
Total Anions					7.8	3.6	4.7	4.8	50	50	0
Total Cations					7.5	3.6	4.8	4.9	50	50	0
Total Dissolved Solids				$1{,}200_b$ $2{,}000_c$	904	128	263	275	96	96	0
Total Hardness, as CaCO3					720	150	210	221	81	81	0
Total Phosphorus		0.05	0.05		1.64	0.005	0.06	0.27	22	17	5
Total Suspended Solids					1	1	1	1	2	2	0
Zinc (T)					0.01	0.01	0.01	0.01	2	2	0

a = Criterion varies with hardness. c = For stock watering.
b = For irrigation.

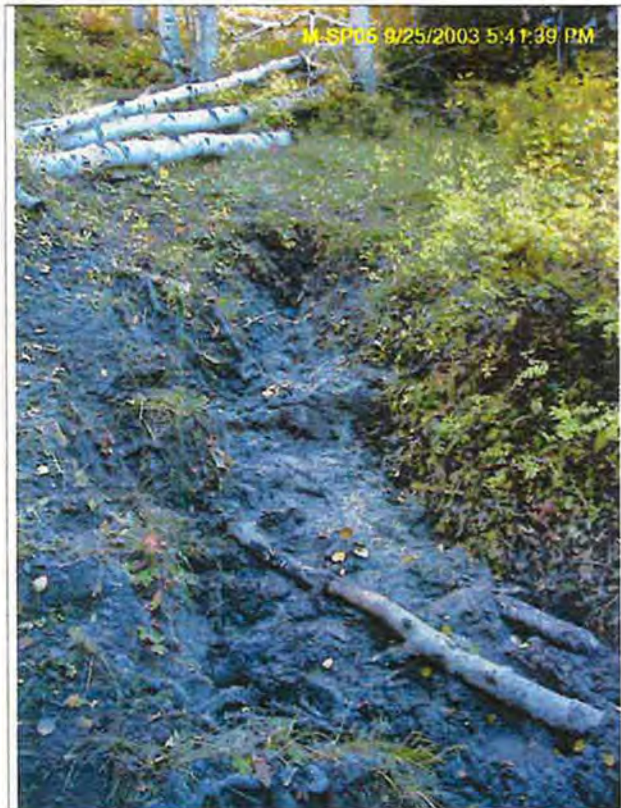
Tract	Muddy
Date of inventory	19 June 2001
Name	M_SP01, Rough Bros. Spring
GPS location	
Northing	4319979
Easting	465615
Comments	Developed spring at Rough Brothers cabin. Water is used as a culinary source of water and for irrigation purposes. Cabin and yard are fenced. Stainless steel spring box is located to the back of the cabin under an old barrel and discharges into a galvanized pipe leading to an underground storage tank and to a trough next to the cabin. Water quality samples were collected periodically for laboratory testing.

Tract	Muddy
Date of inventory	19 June 2001
Name	M_SP02
GPS location	
Northing	4319977
Easting	466086
Comments	Spring box is located next to Greens Hollow road crossing and instrumented by EWCD. Water quality samples were collected periodically for laboratory testing. Information obtained from ranchers indicates that this spring box is the water source for the trough located about 100 feet to the east on the south side of Greens Hollow. Water overflows the cattle trough at down slope end and continues to flow along the south side of Greens Hollow, eventually entering a pond.

Tract	Muddy
Date of inventory	19 June 2001
Name	M_SP03
GPS location	
Northing	4319529
Easting	463762
Comments	Appears to be headwater spring for Greens Hollow. Water originates in stream channel (about 15 feet deep) with some riparian/wetland vegetation growing in the bottom. Channel ends approximately 30 feet upstream from measurement point.



Tract	Muddy
Date of inventory	19 June 2001
Name	M_SP04
GPS location	
Northing	4319267
Easting	464246
Comments	Water originates near base of 2 firs in a small drainage off Greens Hollow. There is no stream channel above the spring. Water flows downstream about 5 feet into tributary, surrounded by a wetland with sedge vegetation. The slope is moderate above the spring's source. Slope appears stable, no evidence of slumping/soil movement. Water quality samples were collected periodically for laboratory testing.



Tract	Muddy
Date of inventory	26 September 2002
Name	M_SP05
GPS location	
Northing	4319133
Easting	464212
Comments	SP05 is seeping out of a small depression, mid-slope and north of SP06, and has very low flow. It was originally considered to be a part of SP06 and field measurements for SP06 were taken below the confluence of the two springs. Starting Sept 2002, both springs were measured separately because cattle heavily trampled the area of confluence.

Tract	Muddy
Date of inventory	19 June 2001
Name	M_SP06
GPS location	
Northing	4319121
Easting	464215
Comments	Field water quality measurements were originally taken below the confluence of two spring/seeps (SP05 and SP06) located in the upper portion of a tributary flowing into Greens Hollow. SP06 is located at the base of an aspen-covered slope (small bench), has much greater discharge than SP05, and forms a small pond. The two springs were measured separately starting Sept 2002 because cattle heavily trampled the area of confluence.

Tract	Muddy
Date of inventory	20 June 2001
Name	M_SP07
GPS location	
Northing	4317433
Easting	465280
Comments	Water originates near the base of slump in an aspen/fir stand. Water flows from this source down to a moderately wide, flat-bottomed drainage (no channel) connected to Cowboy Creek. Water accumulates in floor of drainage, forms small wet pocket, but flow does not reach Cowboy Creek. Water quality samples were collected periodically for laboratory testing.

Tract	Muddy
Date of inventory	20 June 2001
Name	M_SP08
GPS location	
Northing	4317178
Easting	464754
Comments	Developed spring that feeds into cattle trough. Water originates near base of hummock in aspen stand. Originally, most of the flow from spring did not enter pipe but flowed to the side of it. Spring was worked on in 2003. Old pipe was removed and replaced with a new pipe discharging into a different trough. No water in old channel anymore: apparently the new pipe captures all the flow. New trench below spring box with perforated pipe and gravel also captures water from seepy area below the spring. Water quality samples were collected periodically for laboratory testing.

Tract	Muddy
Date of inventory	20 June 2001
Name	M_SP09
GPS location	
Northing	4317141
Easting	464791
Comments	Small seep that enters top of meadow to east of SP08. Water discharges from base of slope in aspen stand, disperses into broad flow after entering meadow. Cattle trample area.

Tract	Muddy
Date of inventory	20 June 2001
Name	M_SP10
GPS location	
Northing	4317562
Easting	467693
Comments	Developed spring with cattle trough (Lowery Springs?). Spring box is about 20 feet up slope of trough on east side of drainage leading down to Cowboy Creek. Water flows from trough across slope, eventually entering channel. Small pocket of sedge below trough (north). Not certain if sedge is supported by a seep or overflow from trough. No water in channel above this location. Instrumented spring, monitored by EWCD. Water quality samples were collected periodically for laboratory testing.

Tract	Muddy
Date of inventory	21 June 2001
Name	M_SP11
GPS location	
Northing	4319958
Easting	462772
Comments	Spring/Pond located approximately 150' up slope of road. Pond appears to collect snowmelt runoff, may also receive some shallow ground water discharge. Field water quality measured in pond, flow measured at discharge side of culvert. Gradual s ope in topography to north. A second pond is located about 50 feet west of SP11 anc is likely hydrologically connected to it

Tract	Muddy
Date of inventory	19 June 2001
Name	M_SP12
GPS location	
Northing	4319397
Easting	464583
Comments	Water originates near toe of slope on small bench above Greens Hollow, discharges through silt bank along a 10 – 2C feet face into pond/wetland area. Flow eventually concentrates into a channel and flows into a second pond below, then into Greens Hollow.

Tract	Muddy
Date of inventory	21 June 2001
Name	M_SP13
GPS location	
Northing	4318345
Easting	462562
Comments	Appears to be the uppermost source of water in Cowboy Creek. Moderately sloped, wide valley. Spring source is located in a slightly incised channel in an aspen stand, just below a point where the channel drops about 2 feet and becomes more incised. This site is usually dry in the fall.

Tract	Muddy
Date of inventory	21 June 2001
Name	M_SP14
GPS location	
Northing	4318227
Easting	462545
Comments	Developed spring originating on gentle slope; spring box located about 50 feet downstream from source. Spring box does not capture all the flow from spring. Cattle trough located 250 feet down slope. Water from spring and overflow from trough enter drainage, eventually reach Cowboy Creek, about 1/4 mile downstream. Flow in Cowboy Creek approximately doubles below confluence. Water quality samples were collected periodically for laboratory testing.

Tract	Muddy
Date of inventory	11 July 2001
Name	M_SP15
GPS location	
Northing	4316685
Easting	463884
Comments	Fairly large seep or wallow on left side of channel near headwater of tributary to North Fork Quitchupah Creek. Good stand of willow and other shrubs around it. This spot is usually pretty well trampled by September. In 2001, flow of tributary below spring was measured instead of spring itself. The area drained by this tributary falls completely within the boundary of the project area. It was assumed that flow in stream was contributed primarily from spring flow, although recent rain activity may have been contributing surface/subsurface flows.

Tract	Muddy
Date of inventory	21 June 2001
Name	M_SP17
GPS location	
Northing	4319385
Easting	461746
Comments	Water originates from seep face at toe of slope in small bowl (bench area) near base of 3 pines, about 50 feet from edge of bench. The water flows through a wet meadow on bench then converges into a steep rocky channel draining the bench area. It enters another wet meadow about 200' down.

Tract	Muddy
Date of inventory	22 June 2001
Name	M_SP18
GPS location	
Northing	4320892
Easting	465794
Comments	Developed spring located at south end of wide, gently sloped valley above Muddy Creek. Field water quality was measured in spring box, which is heavily corroded. Line is broken below spring box, just below fence crossing, and no water reaches trough. Pipe appeared to be plugged or partially plugged on some visits, water appeared stagnant, and dead rodents were found in spring box. Water quality samples were collected periodically for laboratory testing.

Tract	Muddy
Date of inventory	11 July 2001
Name	M_SP19
GPS location	
Northing	4316124
Easting	462644
Comments	Spring originates on a small bench, about 100 feet above an unnamed tributary of North Fork Quitchupah Creek. Two seeps located below have immeasurable flow. Field water quality parameters measured at spring source, flow measured below springs and seeps to obtain total flow from this location. Some evidence of slumping. Best way to locate it is to stay in main channel and look for the confluence with a smaller incised channel.

Tract	Muddy
Date of inventory	11 July 2001
Name	M_SP20
GPS location	
Northing	4316826
Easting	462191
Comments	Spring flows into large (1 acre) meadow that is drained by tributary to North Fork Quitchupah Creek. Spring found in aspen grove near toe of slope. This area is usually trampled by cattle in the fall. Collect field water quality measurements at the first point where steady surface flow is observed. Flow is measured at the downslope edge of meadow where channel drops off. Flow from this spring usually reaches the channel.

Tract	Muddy
Date of inventory	11 July 2001
Name	M_SP21
GPS location	
Northing	4317195
Easting	461814
Comments	First point in channel where flow surfaces; headwater of tributary to North Fork Quitchupah Creek. Look for flagging or tag on small bush or aspen tree at top of channel bank. This site is usually dry during the fall season. Best access is from the end of a spur road coming off the main ATV trail along Big Ridge. 5 minute hike from end of spur road.

Tract	Muddy
Date of inventory	13 July 2001
Name	M_SP25
GPS location	
Northing	4319509
Easting	461537
Comments	Wet area located above road. Small network of seeps drained by a single channel. Many areas appear to have settled: wet areas are as much as 1 – 2 feet below the surrounding soil surface. Field water quality and flow taken immediately below the point of confluence. In May, need to subtract flow discharging from wetland above spring into the channel. This flow comes from snowmelt runoff and SP75 and is not present in the fall.

Tract	Muddy
Date of inventory	13 July 2001
Name	M_SP26
GPS location	
Northing	4319737
Easting	461132
Comments	Developed spring near White Mountain Cabin, surrounded by large seep face on stream bank upstream and downstream from spring. During springtime, measured flow in stream channel above and below spring and seeps in order to calculate entire contribution from spring and seeps. No flow in channel above spring and seeps in the fall.

Tract	Muddy
Date of inventory	13 July 2001
Name	M_SP27
GPS location	
Northing	4320838
Easting	460549
Comments	Water originates in small open bowl, no stream channel evident above this point. Flow from this spring feeds a large beaver pond located 200 feet below. Water discharges from the beaver pond into Black Fork. Field water quality parameters were measured at source, flow was measured about 50 feet upstream from inlet to pond, using a collapsible flume.

Tract	Muddy
Date of inventory	5 October 2001
Name	M_SP28
GPS location	
Northing	4321948
Easting	460757
Comments	SP28 and SP29 are located next to each other on either side of a medium-size spruce tree, on bench area immediately north of Julius Flat reservoir spillway and dam. These springs appear to be above the elevation of the reservoir bottom. During the spring, this area was hiked and appears to be covered by seep flow.

Tract	Muddy
Date of inventory	5 October 2001
Name	M_SP29
GPS location	
Northing	4321956
Easting	460755
Comments	SP28 and SP29 are located next to each other on either side of a medium-size spruce tree, on bench area immediately north of Julius Flat reservoir spillway and dam. These springs appear to be above the elevation of the reservoir bottom. During the spring, this area was hiked and appears to be covered by seep flow.

Tract	Muddy
Date of inventory	19 July 2001
Name	M_SP32
GPS location	
Northing	4323808
Easting	462159
Comments	Confluence of 2 small springs and a larger stream channel that drains a wet meadow above. The wet meadow appears to be a groundwater discharge point and likely collects surface runoff during the snowmelt season. Surface runoff from areas above the meadow was observed in the spring of 2003. Look for a flag and/or metal tag on a small aspen near the confluence of the small tributaries and the larger stream channel. This site is usually dry during the fall. Best access is to follow the cow path along the fence, spring is located about 200 feet below fenceline.

Tract	Muddy
Date of inventory	19 July 2001
Name	M_SP33
GPS location	
Northing	4324453
Easting	462370
Comments	Discharge from a pond, winds through a wetland area then drops into a stream channel and disappears. Stream channel eventually enters North Fork Muddy Creek. Field water quality and flow measured at a 4-foot drop into the stream channel, immediately below the small wetland located below the pond. This site is usually dry during the fall

Tract	Muddy
Date of inventory	19 July 2001
Name	M_SP34
GPS location	
Northing	4324813
Easting	462246
Comments	Combined flows from several seeps and a few springs are concentrated in a stream channel that drops into a large pond. Field water quality parameters measured in this channel, below confluence of flows, about 100 feet above where it drops off to pond. Flow measured at point where channel drops off to pond. Look for flag on large aspen tree

Tract	Muddy
Date of inventory	19 July 2001
Name	M_SP35
GPS location	
Northing	4324550
Easting	461790
Comments	Discharge from a pond fed by a series of other ponds above it. During springtime, water breaches a berm/old beaver dam and flows through some areas covered with tall grass, eventually dropping down a steeper slope to another pond located on a small bench. Flow and WQ are usually measured where the slope begins to drop. This site is usually dry during the fall.

Tract	Muddy
Date of inventory	20 July 2001
Name	M_SP36
GPS location	
Northing	4321859
Easting	463401
Comments	Water originates about mid-slope on a small bench (8 – 10 feet wide) in a stand of aspen/fir with thick brushy understory. Water flows down to a lower bench area where it enters a small channel, eventually reaching the South Fork Muddy Creek about 250 feet below.

Tract	Muddy
Date of inventory	20 July 2001
Name	M_SP37
GPS location	
Northing	4321868
Easting	463357
Comments	This spring is located approximately 200 feet west of SP36, on a moderate slope above the South Fork Muddy Creek. Small amount of slumping noted above water source. Some white crust on soil surface surrounding this location.

Tract	Muddy
Date of inventory	20 July 2001
Name	M_SP38
GPS location	
Northing	4321782
Easting	462767
Comments	Spring originates from base of large rock about 250 feet above South Fork Muddy Creek. Water flows downhill a short distance then splits into two streams. Flow measured at drop created by water flowing across small game trail. Spring is hard to see from above, surrounded by sedge/willow mix. Water quality samples were collected periodically for laboratory testing.

Tract	Muddy
Date of inventory	30 August 2001
Name	M_SP39
GPS location	
Northing	4318775
Easting	466990
Comments	Developed spring located along Cowboy Creek. Includes three spring boxes: top spring box is disconnected and has no flow, only stagnant water; water from middle spring box flows into lower spring box, which discharges into Cowboy Creek. Instrumented spring, monitored by EWCD. Water quality samples were collected periodically for laboratory testing.

Tract	Muddy
Date of inventory	26 September 2001
Name	M_SP40
GPS location	
Northing	4318041
Easting	463677
Comments	Spring originates at the base of a dead tree, on a small bench above Cowboy Creek, approximately 30 feet north of the Creek. Area is usually trampled by cattle.

Tract	Muddy
Date of inventory	26 September 2001
Name	M_SP41
GPS location	
Northing	4318025
Easting	463475
Comments	Water originates near base of a moderate slope covered by aspen/fir. Spring feeds a wetland area adjacent to Cowboy Creek, on south side of creek. Wetland discharges into Cowboy Creek. Best access is from ATV trail along Big Ridge. Short spur road (25 feet) stops at good dropoff point above a barren slope. Hike downslope through opening in trees. Look for wetland/marsh fed by spring along cowboy Creek.

Tract	Muddy
Date of inventory	19 July 2001
Name	M_SP42
GPS location	
Northing	4324682
Easting	462141
Comments	This is the discharge point from what is left of Brush Reservoir. This pond is fed by several seep faces located on the north end. The dam is breached. There is usually a smaller pond/wetland below the larger pond. We measured water quality parameters and flow at the outlet point below the smaller pond on the far south end. Discharge from the smaller pond is concentrated in a small channel that allows flow measurements to be taken. Look for flag or metal tag at brush on cut bank, east side. This site is usually dry in the fall.

Tract	Muddy
Date of inventory	3 October 2001
Name	M_SP43
GPS location	
Northing	4317186
Easting	461919
Comments	This spring originates at the edge of a large clearing at upslope end of a bench above a tributary to the North Fork Quitchupah Creek. No recent slumping observed in the area. The clearing is heavily trampled. Flow is usually measured about 25 feet below the source. Flow usually dries up about 250 feet below source, does not make it to the stream channel.

Tract	Muddy
Date of inventory	3 October 2001
Name	M_SP44
GPS location	
Northing	4317150
Easting	461759
Comments	Water originates near a willow/shrub stand, near the source of an unnamed tributary to the North Fork Quitchupah Creek (M_SP21). Water bubbles up in sand/silt pocket. Area is heavily trampled and flow is usually hard to measure near source. Flow eventually confines into measurable form about 50' below source. May enter tributary at more than one location during springtime. Look for flag and metal tag on willows.

Tract	Muddy
Date of inventory	4 October 2001
Name	M_SP45
GPS location	
Northing	4319780
Easting	465156
Comments	Source is on a narrow bench, approximately 10 – 15 feet wide, above Greens Hollow. Water is discharged from the toe of a small band of rock/shrub. Area immediately around source is fairly undisturbed, area below is heavily trampled.

Tract	Muddy
Date of inventory	5 October 2001
Name	M_SP46
GPS location	
Northing	4322996
Easting	460933
Comments	Spring originates in stump hole left by falling tree. Water flows downhill from this source, eventually reaching an unnamed tributary of the North Fork Muddy Creek. Spring is located in thick timber on bench area approximately 20 feet wide.

Tract	Muddy
Date of inventory	6 October 2001
Name	M_SP47
GPS location	
Northing	4324444
Easting	462151
Comments	Water originates from several locations on a dispersed seep face near a pole fence. Field water quality measured at middle source in a small pool near the base of an aspen. Flow measured down slope from seep face at two different locations, on the east and west side of the slope, where water is concentrated into two stream channels.

Tract	Muddy
Date of inventory	19 October 2001
Name	M_SP48
GPS location	
Northing	4321475
Easting	462500
Comments	Water source is about 350 feet above South Fork Muddy Creek. Slope is mostly barren above a bench area/wet meadow. No surface formations of rock located above this point, as seen at SP38.

Tract	Muddy
Date of inventory	19 October 2001
Name	M_SP49
GPS location	
Northing	4321192
Easting	461704
Comments	Seep face located on small bench approximately 20 x 10 feet, above South Fork Muddy Creek. Area is heavily trampled. Water concentrates as it flows off of bench area and flow can be measured at that point. Second small seep face located immediately to the North (downstream) of this site.

Tract	Muddy
Date of inventory	19 October 2001
Name	M_SP50
GPS location	
Northing	4320883
Easting	461150
Comments	Spring originates near base of steep slope and forms a pool in a wet area about 50 feet below source. Flow measured at pool. Discharge from pool goes subsurface before entering Black Fork Creek as a dispersed seep face, near confluence with South Fork Muddy Creek.

Tract	Muddy
Date of inventory	19 October 2001
Name	M SP52
GPS location	
Northing	4321061
Easting	461044
Comments	Water source is located in the bottom third of steep slope above South Fork Muddy Creek. Water discharges in small depression, consisting of clay material. This soil type appears consistent with the nearby slope. Slope is mostly open above. Field water quality measured at source, flow measured at first point of concentration.

Tract	Muddy
Date of inventory	24 October 2001
Name	M SP53
GPS location	
Northing	4317126
Easting	466373
Comments	This is a developed spring that was connected to a cattle trough (now broken, smashed by fallen tree). Flow is measured from a pipe that appears to run back 10 feet upslope to a pole fence enclosure. Could not find spring box inside enclosure. Surface water disappears about 15 feet below discharge from pipe. Best access is to drop down from ATV trail along Big Ridge. Hike down west side of dry drainage, cut over to the west to spring. Look for old cow path leading to spring.

Tract	Muddy
Date of inventory	25 October 2001
Name	M_SP54
GPS location	
Northing	4321203
Easting	462320
Comments	Spring originates at the base of a large rock near edge of bench. Water meanders along edge of small meadow before dropping into South Fork Muddy Creek.

Tract	Muddy
Date of inventory	25 October 2001
Name	M_SP55
GPS location	
Northing	4321330
Easting	462585
Comments	Spring originates at base of slope under a dead tree, in a deadfall area. Water flows down into a wet meadow, then into South Fork Muddy Creek.

Tract	Muddy
Date of inventory	25 October 2001
Name	M_SP56
GPS location	
Northing	4321469
Easting	462792
Comments	This site contains several small springs and seeps discharging into a wet meadow located on a bench above the South Fork Muddy Creek. Field water quality parameters were measured at the largest spring and flow was measured at the outlet of the wet meadow, at the edge of the bench, below the confluence of all the springs and seeps.

Tract	Muddy
Date of inventory	25 October 2001
Name	M_SP57
GPS location	
Northing	4321845
Easting	463278
Comments	Water source is located approximately 100 feet from the base of a gentle slope. Some evidence of recent slumping above. White crust observed on soil near source. Water moves downslope into a small channel, and then into South Fork Muddy Creek. There is typically no water above this point in the stream channel. Best way to find this site is to follow water up the stream channel to the point where water is seeping down the channel bank. Climb out of channel and follow to source.

Tract	Muddy
Date of inventory	24 October 2001
Name	M_SP59
GPS location	
Northing	4317186
Easting	466357
Comments	Water originates in small bowl (100 square feet), barren and surrounded by pines. Water is somewhat dispersed from source, concentrates about 10 – 20 feet below. Area is usually trampled in the fall. Water flows over edge of bench towards a stream channel located about 150 feet down slope. Water usually disappears about 50 feet or so below the source and does not reach the stream channel. Best access is to drop down from M_SP53.

Tract	Muddy
Date of inventory	2 May 2002
Name	M_SP60
GPS location	
Northing	4316092
Easting	462887
Comments	Water discharges from a depression in the north channel bank (river's left) about 20 feet above the North Fork cf Quitchupah Creek. Turbidity influenced by bank erosion.

Tract	Muddy
Date of inventory	2 May 2002
Name	M_SP61
GPS location	
Northing	4317168
Easting	461881
Comments	Small seep located just west of M_SP43. Area below point of discharge is heavily trampled. Flow disappears about50 feet below source. Measurable flow on north side of wallow.

Tract	Muddy
Date of inventory	23 May 2002
Name	M_SP62
GPS location	
Northing	4321249
Easting	460688
Comments	The location of this seasonal spring was recorded in October 2001 but no measurements were taken until 2002. Water flows on the surface for about 40 feet below the source then appears to go subsurface for a while and to re-surface about 20 feet above the creek. Spring is located in an area of heavy timber, below a canal diverting water to Julius Flat Reservoir.

Tract	Muddy
Date of inventory	23 May 2002
Name	M_SP63
GPS location	
Northing	4322332
Easting	462054
Comments	Spring location was recorded in 2001 but no measurements were taken until 2002. Spring is located under a large conifer tree on a gentle slope leading to Beaver Creek, below the two-track road going around Julius Flat. Area used by wildlife and cattle as evidenced by trails on adjacent slopes.

Tract	Muddy
Date of inventory	23 May 2002
Name	M_SP64
GPS location	
Northing	4322516
Easting	461310
Comments	Spring location was recorded in 2001 but no measurements were taken until 2002. This spring is located on the North side of an unnamed tributary to Beaver Creek.

Tract	Muddy
Date of inventory	23 May 2002
Name	M_SP65
GPS location	
Northing	4323039
Easting	461178
Comments	Spring is located about 150 feet east of a fence, on the south side of an unnamed tributary to the North Fork Muddy Creek. Water issues from the toe of a slope that appears to have slipped. Very hummocky area, close to the creek.

Tract	Muddy
Date of inventory	23 May 2002
Name	M_SP66
GPS location	
Northing	4323061
Easting	461221
Comments	Spring is located on the north side of an unnamed tributary to the North Fork Muddy Creek, on a gentle, grassy slope with downed timber, about 100 feet above the creek. Many leeches in water near source.

Tract	Muddy
Date of inventory	24 May 2002
Name	M_SP67
GPS location	
Northing	4323044
Easting	463654
Comments	Spring is located on a slope about 500 feet above and to the north of the North Fork of Muddy Creek. The spring is surrounded by a patch of juniper trees with a few willows. It crosses over a well-used cattle/wildlife trail.

Tract	Muddy
Date of inventory	24 May 2002
Name	M_SP68
GPS location	
Northing	4323038
Easting	463429
Comments	This spring is located on the North side of the North Fork Muddy Creek, on a steep slope with dense tree and brush cover. It originates at the northwest corner of an aspen stand, just below a stand of Juniper trees. Flow from the spring crosses a well-used trail on its way down to the North Fork. There is a small seep with no measurable flow directly to the east of the spring, about 5-10 feet away.

Tract	Muddy
Date of inventory	24 May 2002
Name	M_SP69
GPS location	
Northing	4323019
Easting	463388
Comments	This spring is located about 300 feet north of the North Fork Muddy Creek, on a steep slope covered with trees and brush. About 50 feet below the source, flow from M_SP70 joins the flow from this spring. Below the confluence, the water crosses a well-used wildlife/cattle trail, then discharges into a small wetland area on a bench on the north bank of the North Fork.

Tract	Muddy
Date of inventory	24 May 2002
Name	M_SP70
GPS location	
Northing	4323017
Easting	463370
Comments	This spring is located about 300 feet north of the North Fork Muddy Creek, on a steep slope covered with trees and brush. It originates in the middle of a tangle of deadfall and is difficult to access. About 50 feet below source, flow from this spring joins flow from SP_69. Below the confluence, the water crosses a well-used wildlife/cattle trail, then discharges into a small wetland area on a bench on the north bank of North Fork.

Tract	Muddy
Date of inventory	25 May 2002
Name	M_SP72
GPS location	
Northing	4324210
Easting	461591
Comments	Water originates from a series of seeps around the remains of an old beaver pond, near the top of a small, narrow valley/drainage channel, on nearly level ground. Water spreads out near origin but eventually concentrates in a single channel about 200 feet from source. This is where water quality parameters and flow were measured. Water moves down from this point through a wet meadow and collects in a pond that appears to have been mechanically created long ago. This spring is usually dry in the fall.

Tract	Muddy
Date of inventory	25 May 2002
Name	M_SP73
GPS location	
Northing	4323056
Easting	461246
Comments	This spring is located about 100 feet east of SP66. Water originates under some deadfall, about 75 feet up the slope to the north of an unnamed tributary to the North Fork Muddy Creek.

Tract	Muddy
Date of inventory	22 May 2002
Name	M_SP75
GPS location	
Northing	4319322
Easting	461676
Comments	Located about 200 - 300 feet above SP25. Flow may be influenced by snowmelt. This spring is usually dry in the fall.

Tract	Muddy
Date of inventory	22 May 2002
Name	M_SP76
GPS location	
Northing	4320377
Easting	461497
Comments	Located above an unnamed tributary to Mill Fork Creek. Spring consists of a large seep and 1 - 3 springs. Flow measured below confluence. Water quality parameters measured on west side. Water does not appear to reach stream channel. Usually no flow in the fall.

Tract	Muddy
Date of inventory	23 May 2002
Name	M_SP77
GPS location	
Northing	4324562
Easting	462136
Comments	Flow comes from 2 springs (north and east) located near a clump of willows. Confluence is about 20 feet below each source. These springs discharge into a stream below. There is a small pond above the north spring but no surface flow is coming from the pond to the spring.

Tract	Muddy
Date of inventory	23 May 2002
Name	M_SP78
GPS location	
Northing	4324492
Easting	462208
Comments	Source is located at the base of a clump of willows. Flow decreases about 100 feet below. Signs of recent slumping above the source. This site is usually dry in the fall.

Tract	Muddy
Date of inventory	23 May 2002
Name	M_SP79
GPS location	
Northing	4323902
Easting	462016
Comments	Large seep that originates just below a barbed wire fence, just west of SP32. Water concentrates into a channel about 30 feet below the fence. Moderate slope, some minor slumping. This site is usually dry in the fall. Best way to access site is to follow fence line from M_SP72.

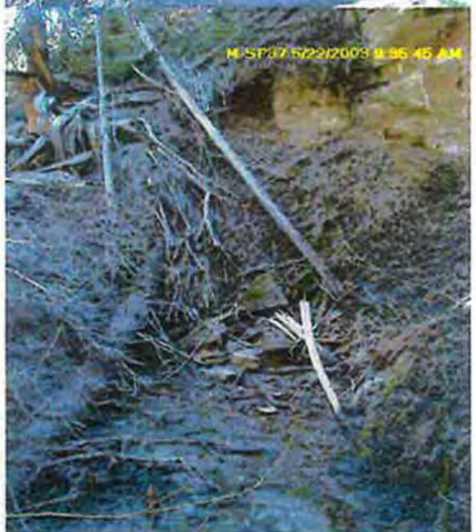
Tract	Muddy
Date of inventory	24 May 2002
Name	M_SP80
GPS location	
Northing	4324971
Easting	467127
Comments	Spring is first point of water discharge within stream channel of unnamed tributary to Horse Creek. Appears to be general groundwater inflow into heavily incised channel. WQ and flow measured about 100' below origin, at flag on willow bush located on west side. Low flow in fall.

Tract	Muddy
Date of inventory	24 May 2002
Name	M_SP81
GPS location	
Northing	4325475
Easting	466804
Comments	Seep at break in slope/small bench above channel of unnamed tributary to Horse Creek. Flow confines about 20' below source.

Tract	Muddy
Date of inventory	25 May 2002
Name	M_SP82
GPS location	
Northing	4323447
Easting	465886
Comments	Spring originates from a rock outcropping at the toe of a slope. Water flows through small riparian area with some willow bushes before joining stream. Look for flagging on pine tree. Best access is from ATV trail (259) directly south of this site. Only about 5 minute walk from ATV trail

Tract	Muddy
Date of inventory	26 May 2002
Name	M_SP85
GPS location	
Northing	4325418
Easting	463713
Comments	Series of springs/seeps located along a stream channel near the boundary of the tract buffer. Flow and water quality measurements taken on the stream, below a large pond/seep area. GPS location is for that measurement point. Total discharge from seeps/springs calculated by substracting flow in stream channel at tract buffer boundary from flow in stream channel below the seeps. Need flume to measure flow at this site.

Tract	Muddy
Date of inventory	26 May 2002
Name	M_SP86
GPS location	
Northing	4325195
Easting	463889
Comments	Seep/spring area located downstream of SP85 along same stream channel. Water quality and flow measurements taken in stream channel at a small wildlife crossing, just below the lowest seep. Small seep area just above on left side when looking upstream. Total discharge from seeps/springs calculated by subtracting flow in stream channel below M_SP85 from flow in channel below M_SP86. Need flume to measure flow at this site.



Tract	Muddy
Date of inventory	26 May 2002
Name	M_SP87
GPS location	
Northing	4322427
Easting	465309
Comments	Spring originates under a large overhang about 250 feet above Muddy Creek. Can be hard to find as GPS usually does not work. Take ATV trail down to a good cattle trail that parallels Muddy Creek. Follow cattle trail downstream until it crosses a side-drainage, move past drainage, drop down below trail, and look for flagging.

Tract	Muddy
Date of inventory	25 June 2002
Name	M_SP88
GPS location	
Northing	4318191
Easting	470255
Comments	Spring located in Box Canyon main stem above confluence with East Fork Box Canyon. Appears to be Pines #307. Water emerges above and below a rock face near the bottom of the canyon, just above the stream.

Tract	Muddy
Date of inventory	25 June 2002
Name	M_SP89
GPS location	
Northing	4318092
Easting	470404
Comments	This spring is located in a stand of aspen/fir about mid-slope in Box Canyon, just above the confluence with the East Fork Box Canyon. Water originates in a small depression with scattered rock outcroppings around and above the spring.

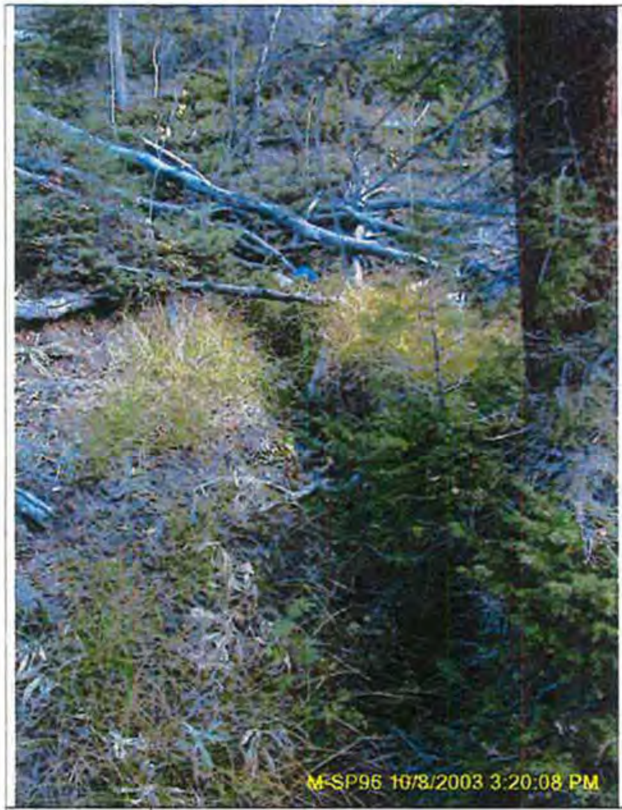
Tract	Muddy
Date of inventory	26 June 2002
Name	M_SP90
GPS location	
Northing	4318157
Easting	470201
Comments	Water discharges from a large sandy slump about 100 feet above Box Canyon creek. Slump appears fairly recent (15 - 25 years). The whole sloughed off area is seeping and discharging into the creek in many places. Could not measure total flow for the whole seep. Water quality was measured at the largest spring and flow at the two main springs. The other seeps were immeasurable. Slope is saturated with water and keeps sliding down in mudslides when walked on, making measurements difficult.

Tract	Muddy
Date of inventory	26 June 2002
Name	M_SP91 (Pines 202)
GPS location	
Northing	4317250
Easting	469623
Comments	Appears to be Pines #202. Originates on very steep, unstable slope, about 100 feet above Box Canyon creek. Seepy area to the south of spring has no measurable flow.

Tract	Muddy
Date of inventory	25 June 2002
Name	M_SP93 (Pines 216)
GPS location	
Northing	4317428
Easting	471356
Comments	This spring originates on the northeast side of the East Fork Box Canyon, on a narrow bench below a cliff, and crosses a well-used wildlife/cattle path. This spring appears to be Pines #216 and is marked with a stake labeled "EFB52(N)". The spring/seep 20 feet to the east was flowing very slowly at the time of the first visit, not measurable. On subsequent visits, it was measured as SP98. After SUFCO mined under the East Fork Box Canyon in the winter of 2003-2004, both springs stopped flowing and were covered by a rockslide.

Tract	Muddy
Date of inventory	25 June 2002
Name	M_SP94 (Pines 217)
GPS location	
Northing	4317389
Easting	471375
Comments	This spring originates on the northeast side of the East Fork Box Canyon, on a narrow bench below a rock face, and crosses a well-used wildlife/cattle path. This spring appear to be Pines #217 and is marked with a stake labeled "EFB53(N)". There is another spring/seep about 50 feet to the south that was not flowing at the time of the first visit. On subsequent visits, that second spring was measured as SP99. After SUFCO mined under the East Fork Box Canyon in the winter of 2003-2004, both springs stopped flowing (unlike SP93 and SP98, they were untouched by rockslides).

Tract	Muddy
Date of inventory	26 June 2002
Name	M_SP95
GPS location	
Northing	4317704
Easting	469914
Comments	This measurement point is located in same channel as SP97, lower in the channel, in a thick stand of trees just above Pines #206. Some of the water is coming from SP97, with some additional flow coming from seeps/springs just above this point. Snowdrifts also contribute to flow in the spring.



Tract	Muddy
Date of inventory	26 June 2002
Name	M_SP96 (Pines 211A)
GPS location	
Northing	4317260
Easting	469657
Comments	This spring is located in a stand of aspen/fir mix above the main stem of Box Canyon. A metal tag at source is labeled Pines 211A. A tag found at creek nearby has 212 and 203 written on it.

Tract	Muddy
Date of inventory	28 September 2002
Name	M_SP97 (Pines 207)
GPS location	
Northing	4317699
Easting	469937
Comments	Water appears from under a big boulder in the stream channel. Metal tag near source is labeled Pines 207. This spring is difficult and somewhat dangerous to get to, due to extremely steep slopes and cliffs surrounding it. Water is dripping from a big overhang just upstream of the spring but no measurable flow there. Water flows on surface for about 70 feet below spring then disappears. It reappears with additional flow from other seeps/springs at SP95.

Tract	Muddy
Date of inventory	27 September 2002
Name	M_SP98 (Pines 216A)
GPS location	
Northing	4317434
Easting	471365
Comments	This spring originates on the northeast side of the East Fork Box Canyon, on a narrow bench below a cliff, and crosses a well-used wildlife/cattle path. This spring appears to be Pines #216A and is marked with a stake labeled "EFB52(S)". It is located just east of SP93. After SUFCO mined under the East Fork Box Canyon in the winter of 2003-2004, both springs stopped flowing and were covered by a rockslide.

Tract	Muddy
Date of inventory	27 September 2002
Name	M_SP99 (Pines 217A)
GPS location	
Northing	4317375
Easting	471376
Comments	This spring originates on the northeast side of the East Fork Box Canyon, on a narrow bench below a rock face, and crosses a well-used wildlife/cattle path. Water disappears underground near edge of bench and reappears on slope just below bench. This spring appear to be Pines #217A and is marked with a stake labeled "EFB53(S)". It is located about 50 feet south of SP94. After SUFCO mined under the East Fork Box Canyon in the winter of 2003-2004, both springs stopped flowing (unlike SP93 and SP98, they were untouched by rockslides).

Tract	Muddy
Date of inventory	27 September 2002
Name	M_SP100
GPS location	
Northing	4316719
Easting	463616
Comments	This spring is located 75 feet above the stream channel of an unnamed tributary to Quitchupah Creek, upstream of SP15. A seep face is located 10 feet upstream of this spring. No flow in channel above this point.

Tract	Muddy
Date of inventory	28 September 2002
Name	M_SP101
GPS location	
Northing	4322527
Easting	461364
Comments	This spring is located on a gentle slope above an unnamed tributary to Beaver Creek, about 150 feet east of SP64 and 75 feet east of SP110. Flow from a seep directly to the west of this spring joins flow from SP101 before discharging into the creek.

Tract	Muddy
Date of inventory	8 October 2002
Name	M_SP102
GPS location	
Northing	4322997
Easting	463336
Comments	This spring is located on the North side of the North Fork Muddy Creek, on a steep slope covered with trees and brush. Flow from the spring crosses a well-used game trail on its way down to the North Fork. Many leeches in water near source.

Tract	Muddy
Date of inventory	21 May 2003
Name	M_SP103
GPS location	
Northing	4316302
Easting	463271
Comments	Found this new spring on the way to M_SP60 is a small slide area. Flow originates at base of cliff. Not certain how far down the water travels; it does not appear to reach the river below. Located just east of SP104

Tract	Muddy
Date of inventory	21 May 2003
Name	M_SP104
GPS location	
Northing	4316335
Easting	463250
Comments	This spring is located just west of M_SP103. Flow disappears 30 feet below source. Water picks up a lot of silt, making it very turbid.

Tract	Muddy
Date of inventory	21 May 2003
Name	M_SP105
GPS location	
Northing	4316280
Easting	463233
Comments	This spring was found about 150 feet southwest of SP104.

Tract	Muddy
Date of inventory	21 May 2003
Name	M_SP106
GPS location	
Northing	4316155
Easting	462626
Comments	Spring is located about 100 feet west of M_SP19, above an unnamed tributary of the North Fork Quitchupah Creek.

Tract	Muddy
Date of inventory	24 May 2002
Name	M_SP107
GPS location	
Northing	4323024
Easting	463091
Comments	Spring is located above and feeds an extensive pond/wetland complex located on several benches to the north of the North Fork Muddy Creek. Very light cattle/wildlife use. Very nice. Thick grass and moss. Pond is about 75 x 100 feet and has fish (Pond E). Water goes from pond down into creek. (Note: somehow this spring and SP_70 were assigned the same ID and were mixed up when the data was entered after this first visit. As a result, this spring was not visited in the fall of 2002 because we didn't realize it existed.)

Tract	Muddy
Date of inventory	3 June 2003
Name	M_SP108
GPS location	
Northing	4322999
Easting	463359
Comments	Located between SP70 and SP102

Tract	Muddy
Date of inventory	4 June 2003
Name	M_SP109
GPS location	
Northing	4321387
Easting	462075
Comments	This spring was found while walking between SP49 and SP48. Spring is on the hillside just above a small wetland, on the north side of the North Fork Muddy Creek. There are a few large fir trees in the area. Water comes out of the ground, stays above ground for only a few feet, then disappears for about 5 ft, then flows above ground again

Tract	Muddy
Date of inventory	25 September 2003
Name	M_SP110
GPS location	
Northing	4322520
Easting	461347
Comments	Small spring located approximately midway between SP64 and SP101, on a gentle slope above an unnamed tributary to Beaver Creek

Tract	Muddy
Date of inventory	7 October 2002
Name	M_SP111
GPS location	
Northing	4320391
Easting	461597
Comments	This spring was originally mistaken for SP76, which was not flowing at the time, but later proved to be a new spring. It is located on a fairly steep, forested north-facing slope with some deadfall, 300 – 400 feet to the east of the actual SP76 Elk and elk sign were observed near this spring

FINAL SUPPLEMENTAL

ENVIRONMENTAL IMPACT STATEMENT

FOR THE LEASING AND UNDERGROUND MINING OF THE

GREENS HOLLOW FEDERAL COAL LEASE TRACT

UTU-84102

SANPETE AND SEVIER COUNTIES, UTAH

Lead Agencies:

U.S. Department of the Interior
Bureau of Land Management
Price Field Office
Price, Utah

U.S. Department of Agriculture
Forest Service
Manti-La Sal National Forest
Price, Utah

U.S. Department of Agriculture
Forest Service
Fishlake National Forest
Richfield, Utah

Cooperating Agency:

U.S. Department of Interior
Office of Surface Mining Reclamation and Enforcement
Denver, Colorado

February 2015

4.0 CHAPTER 4 – ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

4.1 INTRODUCTION

This chapter discusses the environmental consequences of implementing the Proposed Action and alternatives as described in Chapter 2. It compares the impacts associated with each action alternative to the No Action Alternative. Under NEPA, actions which could significantly affect the quality of the human environment must be disclosed and analyzed in terms of the "context and intensity" that makes them significant. For an action to have an effect, it must have a demonstrable causal relationship, which can be direct, indirect, or cumulative in nature (40 CFR 1508.27). In the discussion that follows, the potential effects of each alternative are identified and discussed by each resource described in Chapter 3. Impacts are discussed with respect to each issue statement developed from public and agency scoping. The treatment of effects for the alternatives and elements is considerably more detailed than the summary of potential impacts in Chapter 2 (Table 2.2).

Leasing results in a conveyance of rights to the mineral resource, and thus has no direct effects on the ground; however, indirect effects could occur as a result of leasing and subsequent receipt of a permit for development. This analysis includes conditions for the Proposed Action and Alternative 3. Recommended measures to reduce the potential effects of the action alternatives and the likely effectiveness of these measures are presented at the end of each resource discipline discussion of direct and indirect impacts. In addition, cumulative effects are described for each resource as identified in Chapter 2 (Table 2.1). Where pertinent, each resource section also includes sections describing unavoidable adverse impacts, effects related to short-term uses versus long-term productivity, and the irreversible or irretrievable commitment of resources.

4.1.1 EXISTING MINE AND RELATIONSHIP TO THE GREENS HOLLOW TRACT

The Greens Hollow tract is located in the southern Wasatch Plateau where there are other coal leases, including the Quitchupah, Pines, and SITLA leases. These existing leases have been mined using longwall methods, and mining is continuing in portions of these leases. Subsidence impacts of the mining have been studied and documented in Anderson (2008a), Bigelow (2009), Canyon Fuel Company (2007), Mayo and Associates (1999), Petersen (2006, 2007, and 2009), and Thiros and Cordy (1991). A primary concern with subsidence mining is potential impacts to water resources and corresponding impacts on dependent resources, including vegetation, wildlife, and rangelands.

Beginning in late 2003, mining in the Pines Coal Lease undermined and subsequently subsided the North Water area, a tributary to the East Fork of Box Canyon (see Figure 4.1). Subsidence of the North Water Canyon area of the East Fork of Box Canyon in the winter of 2005 to 2006 resulted in the loss of flow at three springs (Pines 105, Pines 311, and Pines 310 Lower), the loss of water in two ponds, relocation of spring discharge at 3 springs and the depletion of surface and alluvial (subsurface) flow supporting a major riparian area (Petersen 2009). No flow to these areas has been restored (Weiser 2009). A mitigation plan to restore the North Water spring area has been finalized (Canyon Fuel Company 2013) and recently approved (DOGM 2013b). Although surface discharge is currently lost from 3 springs, stream monitoring below the springs has indicated the Castlegate Sandstone groundwater system that supported surface discharge from these springs, continues to function and provides groundwater flow at pre-subsidence levels in the East Fork of Box Canyon Creek (Petersen 2009). Subsidence has also occurred beneath many other springs along the East Fork of Box Canyon in the Pines Coal Lease without impacting discharge.

Surface tensile cracks also occur in upland areas post subsidence, particularly where cover above the Castlegate Sandstone is limited. In these areas, hydrologic impacts could occur during periods of overland flow if cracks remain open. Due to the lack of overburden above the Castlegate Sandstone layer, "healing" of the cracks has been much slower. In order to draw inferences between the impacts that were observed in the North Water area and the potential for similar impacts to occur in the Greens Hollow tract, this section compares the geology and hydrology of the North Water Canyon area of the Pines Coal Lease with the Greens Hollow tract.

The sedimentary geology is the dominant factor influencing the hydrologic system of the area. The geology also determines how subsidence affects the surface resources of the area. The geologic units of importance for this comparison, listed from bottom to top (oldest to youngest), with their dominant characteristics that could influence hydrology and other resources, are as follows (see also Figure 3.2):

Blackhawk Formation: This unit consists of interbedded sandstone, siltstone, shale, and coal. The economic coal seams occur near the base of the Blackhawk Formation. The shale from the Blackhawk Formation was examined by X-ray diffraction and found to contain an average of 24 percent smectite, a swelling clay. (DOGM 2005). These swelling clays decrease the vertical hydraulic conductivity, which impedes the vertical flow of ground water in the Blackhawk Formation. Therefore, the upper portion of this formation is nearly impervious and generally perches water in the basal portion of the Castlegate Sandstone.

Castlegate Sandstone: This unit is a massive (blocky) fluvial sandstone with minor interbedded conglomerate and rare siltstone or shale. The unit is porous and permeable and is an important aquifer. The Castlegate Sandstone has a prominent fracture pattern and prominent bedding planes. Minor thin lenses of gray to carbonaceous shale as well as coal pods may be present. Weathered Castlegate Sandstone results in sandy sediments that are ineffective in sealing cracks in the surface-exposed, consolidated sandstone and does not prevent the downward flow of water. Abundant swelling clays at the contact border with the Blackhawk Formation impede downward movement of ground water and result in lateral movement. Structure appears to influence groundwater flow in the Castlegate Sandstone in the Greens Hollow and Pines Lease tracts as all of the springs are located on the east or southeast side of the canyons in these areas (Cirrus 2004), as would be expected for ground water following the dip slope.

Price River Formation: This unit is a deposit of chiefly sandstone with interbedded siltstone and shale, with minor conglomerate. Where it occurs, shale deposits severely restrict vertical flow of ground water to deeper units. This process is indicated by the relatively larger number of springs that issue from the Price River Formation in comparison to other geologic formations such as the Castlegate Sandstone. Indications of extensive unsaturated horizons in the Price River and Castlegate Sandstone Formations found in drill holes and wells in the Pines Coal Lease Tract, suggest that perched ground water conditions are likely (Forest Service 1999).

North Horn Formation: This unit is similar to the Price River Formation, but is mostly shale with interbedded siltstone and sandstone. The shaley nature of the formation and its occurrence at higher elevations that receive more precipitation make it vulnerable to mass movement, slope failures, and landslides. The shales and clays of the North Horn Formation serve to retard the vertical flow of water causing ground water to move horizontally along bedding planes or through fractures. Similar to the Price River Formation, this process is evident due to the relatively larger number of springs that discharge from this formation in comparison to the Castlegate Sandstone Formation.

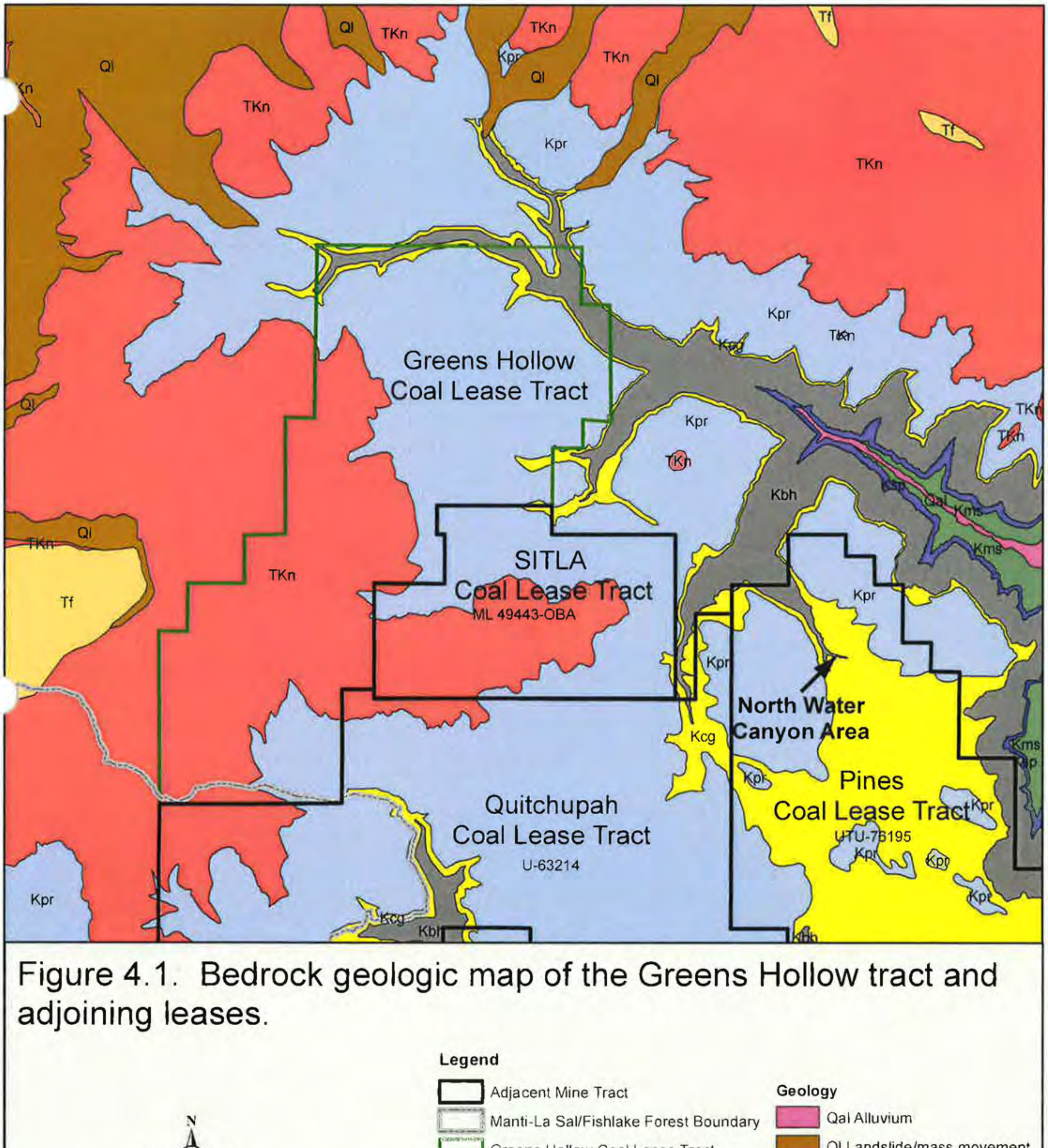


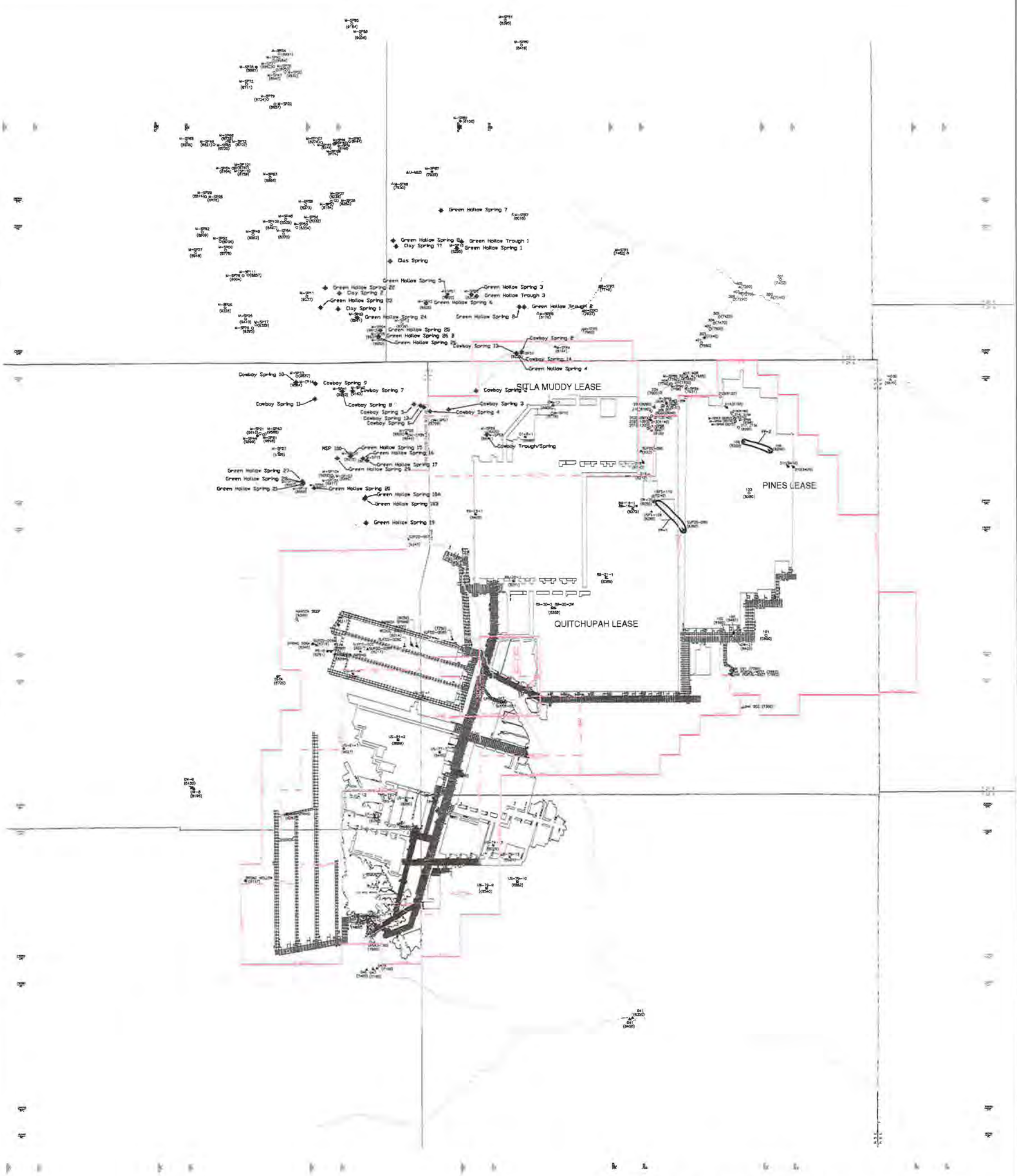
Figure 4.1. Bedrock geologic map of the Greens Hollow tract and adjoining leases.

A primary difference between the Greens Hollow tract and the Pines Tract is the geologic units or stratigraphy exposed on the surface of the tracts (Figure 4.1). The Price River Formation is present over only about 25 percent of the Pines Tract. The majority of the Price River Formation in the Pines Coal Lease Tract ranges in depth from 0 to 50 feet with some areas ranging in depth from 100 to 500 feet. Most of the surface of the tract consists of Castlegate Sandstone with little soil cover. The North Water Canyon area of the Pines Coal Lease, where the springs, ponds, and alluvial flow were lost, is very near the top of the Castlegate Sandstone where the unit is exposed at the surface (Figure 4.1). Hence, soils in the North Water Canyon area are derived from the Castlegate Sandstone and predominantly clean, well-sorted sand with very little silt or clay-sized material. When undermined, fractures form in zones of permanent tension, around the margins of each longwall panel, which tend to remain open. Over time, the surface tension fractures tend to fill with the available sandy soil. However, because this material is sand, with little silt and clay, it has a high porosity and permeability and has little potential to hydraulically seal the fractures. Therefore, springs and drainages lost to the subsidence cracks or fractures can be permanently dewatered and surface fractures outside the riparian habitat can remain permanently open to water flow.

In contrast, over most of the Greens Hollow tract, the Price River and North Horn Formations are mapped as the surface-exposed bedrock units and overlay the Castlegate Sandstone (Figure 4.1). Exposed or shallowly buried Castlegate Sandstone layers in the Greens Hollow tract are limited to the extreme north and northeast edge of the tract in the lower Cowboy Creek, lower Greens Hollow, and Muddy Creek drainages. These areas, approximately 3 percent of the tract, correspond to the upper extent of the Castlegate Sandstone and are the only places on the tract where it is exposed on the surface. South and west of these areas the Price River Formation thickness increases quickly and then transitions to the North Horn Formation (gaining up to 1,700 feet in thickness above the top of the Castlegate Sandstone). The soils formed on the Price River and North Horn Formations contain abundant silts and clays. When compared to the Castlegate Sandstone, the silts and clays in the Price River and North Horn Formations are more likely to deform and are less likely to propagate subsidence-caused tension fractures to the surface. Thicker cover above the Castlegate Sandstone reduces the severity of subsidence impacts at the surface due to the dampening effect of the increased thickness.

It is the judgment of professionals (i.e., Hamid Maleki [mining engineer], Paul Anderson [project geologist], Katherine Foster [FS Hydrologist], and Art O'Hayre [hydrogeologist]), that where the Castlegate Sandstone is buried by 50 feet or more of overburden of the Price River and North Horn Formations, silts and clays are present in sufficient quantities to seal subsidence cracks over time (the period varies depending on precipitation levels and erosion rates) through the processes of weathering, surface erosion, and deposition. The clays contain about 24 percent smectite clay (DOGM 2005), which swells when hydrated, effectively sealing fractures and stopping the downward flow of water. Therefore, the areas where hydrologic impacts similar to those experienced in the North Water Canyon area could occur are limited to the lower Cowboy Creek, lower Greens Hollow, and Muddy Creek drainages where the Castlegate Sandstone is at or near the surface. Widespread subsidence impacts across the Greens Hollow tract similar to those experienced in the North Water Canyon area would not be expected. Excluding areas where hydrologic impacts could be similar to those experienced in the North Water Canyon area was a large factor in the formulation of Alternative 3. The potential impacts for Alternative 2, however, in the area where the Castlegate Sandstone is at or near the surface could be similar to those experienced in the North Water Canyon area.

Based on the geology/stratigraphy and hydrology of the two tracts, anticipated impacts to other resources would also be quite different between the Pines Tract and the Greens Hollow tract and are discussed in this EIS on a resource by resource basis.



NOTES:
1. HISTORIC STREAM, SPRING AND WELL MONITORING SITES ARE OLD BASELINE MONITORING SITES OR SITES THAT HAVE BEEN DISCONTINUED OR MINED THROUGH THAT ARE NOT CURRENTLY BEING MONITORED.

EXPLANATION

SUFCO MINE EXTERIOR LEASE BOUNDARY
SUFCO MINE INTERIOR LEASE BOUNDARY
MINE COORDINATES
STATE PLANE COORDINATES
HISTORIC STREAM
STREAM MONITORING
HISTORIC MONITORING WELL
MONITORING WELL SITE
HISTORIC SPRING MONITORING SITE
SPRING MONITORING
UPDES MONITORING POINT
IN-MINE MONITORING SITE
(7600) ELEVATION OF SITE
PERENNIAL FLOW LOCATION MONITORING POINT
PERENNIAL FLOWS
SPRING NOT MONITORED
FOREST SERVICE 2014 MONITORING

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MANTI-LA SAL FOREST WATER MONITORING LOCATIONS DRAWING 2013 - 2015

Comparision of Manti-LaSal Forest Water Monitoring and Sufco Water Monitoring 2004, 2013, 2014, 2015

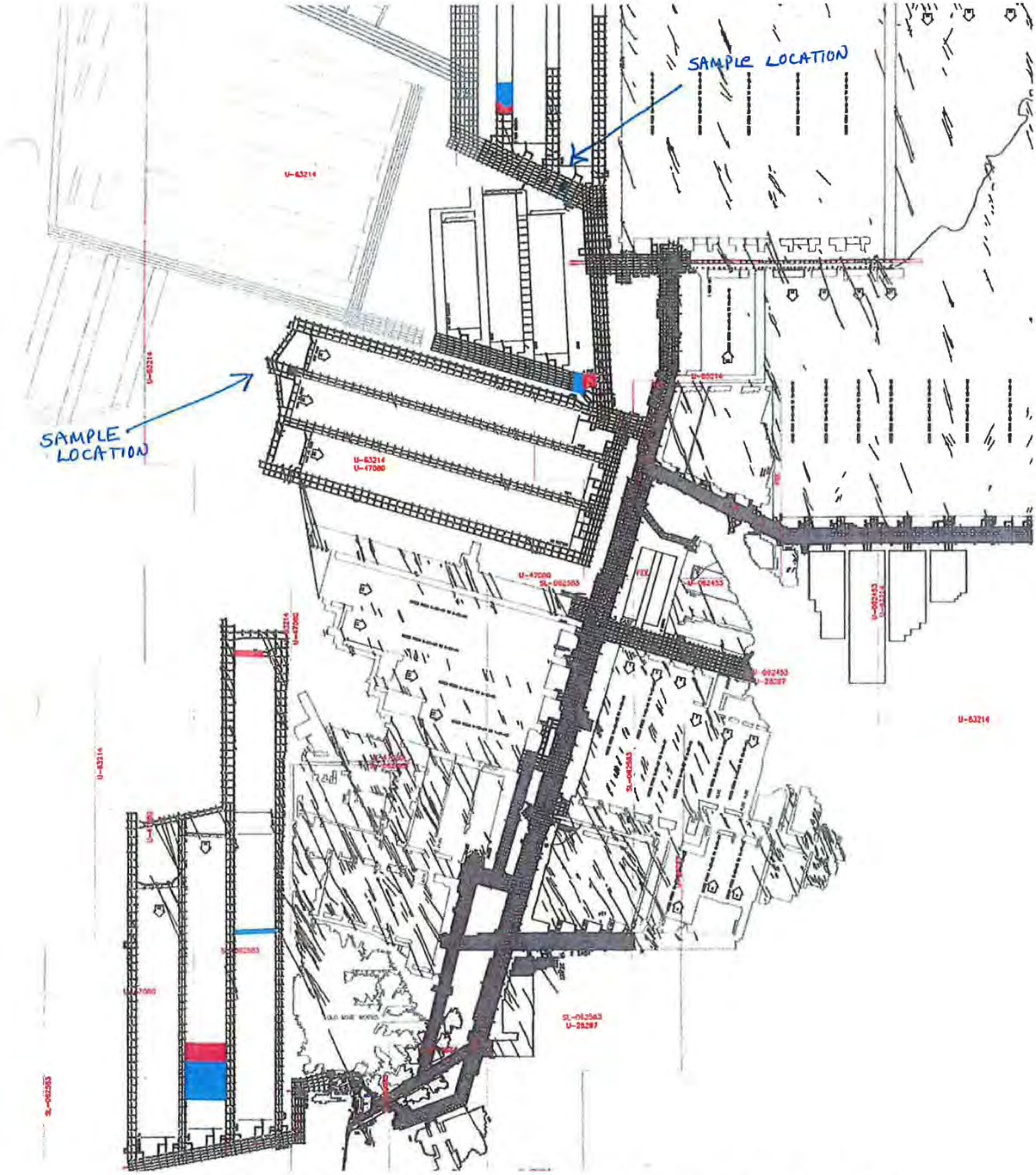
Manti-LaSal Forest Name of Spring	Sufco Monitoring Site No.	X Coordinate (FS)	Y Coordinate (FS)	2004 & 2013 Sufco Historic Flow	2013 (FS) Flow Rate (gal/min)	2013 (FS) Date	2014 Sufco Historic Flow	2014 (FS) Flow Rate (gal/min)	2014 (FS) Date	2015 (FS) Flow Rate (gal/min)	2015 (FS) Date	Source Type	Field Notes (FS)
Green Hollow Spring 1	M-SP18 (M)	465730	4321098	0.115 6/30/13	None	6/27/2013	<0.05 6/29/14	None	6/4/2014	0.23	6/22/2015	Seep	Cylinder in ground, no flow in cylinder seen, ground wet around cylinder
Green Hollow Spring 2		466978	4319927		0.26	6/27/2013		None	6/9/2014	2.33	6/22/2015	Seep	Creek from upstream merges with seep, so can't measure the spring flow
Green Hollow Spring 3	M-SP02 (M)	466021	4320183	0.063 6/30/13	0.03	6/27/2013	Seep 6/29/14	None	6/9/2014	None	6/22/2015	Seep	Developed box, but no flow, water inside and down from box
Green Hollow Spring 4	M-SP39 (M)	466922	4318979	1.44 6/28/13	1.4	6/27/2013	1.61 6/29/14	1.6932	6/4/2014	0.99	6/24/2015	Spring	Box, pipes on side of main flow. Not much water is coming through development. Also a white pipe on side with decent flow we added in, not sure where flow is going. We got the flow by turning valves. This spring is in a cluster with Cowboy Springs 13 & 14.
Green Hollow Spring 5	M-SP01 (M)	465519	4320142	0.292 6/30/13	0.31	6/27/2013	0.32 6/29/14	0.55696	6/9/2014	0.36	7/8/2015	Spring	Right by a cabin and fenced in. Very inconsistent flow out of pipe. Pipes bring water to a barrel trough
Green Hollow Spring 6	M-SP45	465106	4320014	0.673 6/5/04		6/27/2013	- - - -	1.2941	6/10/2014	0.93	6/23/2015	Spring	No development. There is a cabin about 800 ft. downstream
Green Hollow Spring 7		465420	4321861		None	7/2/2013		0.14458	6/9/2014	.08	6/22/2015	Spring	Lots of fallen trees over the spring, meausrment difficult due to slow flow
Green Hollow Spring 8		464453	4321263		None	7/2/2013		None	6/9/2014	None	6/22/2015	Seep	No development.
Green Hollow Spring 15		463580	4316947		0.31	7/9/2013		0.2652	6/2/2014	None	7/22/2015	Spring	Trampled by cows, flow from MSP 100 flows in close by. Track name is correctly entered.
Green Hollow Spring 16	M-SP15	463810	4316882	0.268 6/5/04	None	7/9/2013	- - - -	0.259	6/2/2014	None	7/22/2015	Spring	Trampled by cows
Green Hollow Spring 17		463894	4316844		0.21	7/9/2013		0.29596	6/2/2014	None	7/22/2015	Spring	This spring flows only 1 foot before it joins the main creek
Green Hollow Spring 18A		463855	4316094		None	7/9/2013		0.1756	6/2/2014	None	7/26/2015	Spring	Spring was very difficult to measure
Green Hollow Spring 18B		463842	4316060		0.23	7/9/2013		0.235	6/2/2014	None	7/26/2015	Spring	Flows may have contained flow from GRNHLWSP18A
Green Hollow Spring 18C		463852	4316079							0.28	7/27/2015	Spring	Difficult to measure seeping over a large area, measured a distance below source
Green Hollow Spring 19		463863	4315573		0.24	7/9/2013		1.0761	6/3/2014	0.28	7/26/2015	Spring	Spring flows about 6 feet to creek
Green Hollow Spring 20	M-SP60 (M)	462825	4316290	0.676 6/5/04	0.68	7/9/2013	0.72 6/30/14	0.7034	6/3/2014	0.49	7/22/2015	Spring	Flows directly to Quitchumpah Creek
Green Hollow Spring 21		462602	4316374		1.95			0.1176	6/3/2014	0.38	7/22/2015	Spring	Spring on edge of stream, very easy to miss, flows for 1 foot before entering main stream. Possibly underground flow from main stream.
Green Hollow Spring 22		463081	4320324		None			0.1682	6/16/2014	0.15	6/22/2015	Spring/seep	Lots of scattered cow bones. One flow we could measure, but the rest is a large seep.
Green Hollow Spring 23		462984	4319938		None	7/16/2013		0.1505	6/16/2014	None	6/22/2015	Spring	Trampled by cows
Green Hollow Spring 24	M-SP03	463717	4319726	1.949 6/3/04	None	7/16/2013	- - - -	1.5469	6/10/2014	0.89	6/25/2015	Spring	Couldn't pinpoint one spring. Creek starts flowing much fuller than above after it goes through section.
Green Hollow Spring 25	M-SP04	464182	4319466	2.921 5/12/04	0.76	7/16/2013	- - - -	2.4146	6/10/2014	1.53	6/25/2015	Spring	No development, spring runs directly to stream, no wetland around it
Green Hollow Spring 26	M-SP06 (M)	464144	4319328	1.624 5/12/04	1.44	7/16/2013	1.47 6/30/14	1.4488	6/10/2014	1.37	6/25/2015	Spring	Smelled like sulphur, flow combined for 26 and 26 B
Green Hollow Spring 26 B	M-SP05	464148	4319344	0.264 5/12/04			- - - -	0.1841	6/10/2014	0.13	6/25/2015	Spring	Close to GRNHLWSP26
Green Hollow Spring 27		462589	4316428					0.1295	6/3/2014	None	7/22/2015	Spring	Trampled by cows
Green Hollow Spring 28		462606	4316393					0.597	6/3/2014	None	7/22/2015	Spring	Flows about 3 feet until it reaches large creek, much colder than main stream though.
Green Hollow Spring 29		463294	4316888					0.7444	6/2/2014	0.47	7/22/2015	Spring	Trampled by cows
Green Hollow Spring 30		463758	4319694							None	6/25/2015	Seep	Trampled by cows and deer. It runs into the GRNHLWSP24 stream
Green Hollow Spring 31		463958	4319425							0.18	6/25/2015	Spring	No development. The track is the head of the spring where there is a small wetland area
Green Hollow Spring 32		462590	4316362							2.11	7/22/2015	Spring	Very difficult to navigate. The head is direcly west , difficult due to deadfall
Green Hollow Spring 33		463087	4317259							0.036	7/22/2015	Seep	No development, So slow it is difficult to get an accurate flow.
Green Hollow Trough 1		465828	4321235		0.13	6/27/2013		None	6/4/2014	None	6/22/2015	Trough	Dead mice, no water flowing in or out as far as we can tell.
Green Hollow Trough 2		467080	4319923		0.155	6/27/2013		3.1935	6/9/2014	None	6/23/2015	Trough	There is a leak between the two circular troughs.
Green Hollow Trough 3		466126	4320148		0.11	7/2/2013		1.52788	6/9/2014	None	6/23/2015	Trough	Trough is dry completely. Upstream, the pipe is broken with lots of water coming out.
Cowboy Spring 2		466097	4318234		0.43	7/10/2013		None	6/4/2014	None	6/24/2015	Seep	Both trough empty and half full of dirt , pipe broken
Cowboy Spring 3		465542	4317857		0.12			0.1877	6/4/2014	0.11	7/8/2015	Spring	Some flow, mostly large seep. Flows were hard to collect. Trampled by cows.
Cowboy Spring 4		465169	4317821		None	7/10/2013		0.2183	6/4/2014	0.12	7/8/2015	Spring	Source is about 65 higher than waypoint.
Cowboy Spring 5		464847	4317966		0.33	7/31/2013		0.9542	6/4/2014	0.43	7/8/2015	Spring	Source is 105 feet higher than waypoint, stream flows into stagnant pond.
Cowboy Spring 6		465043	4317906		0.55	7/31/2013		None	6/4/2014	None	7/8/2015	Seep	No development
Cowboy Spring 7	M-SP40	463613	4318245	0.447 6/6/04	0.24	8/7/2013	- - - -	0.3023	6/12/2014	0.17	7/20/2015	Spring	No development and trampled
Cowboy Spring 8	M-SP41 (M)	463407	4318235	0.509 6/6/04	0.28	8/7/2013	- - - -	1.633	6/12/2014	1.14	7/20/2015	Spring	No development
Cowboy Spring 9		462868	4318398		None	8/12/2013		None	6/12/2014	None	7/6/2015	Seep	Trampled
Cowboy Spring 10	M-SP14	462477	4318430	61.402 6/6/04	None	8/12/2013	- - - -	20.09	6/12/2014	4.33	7/6/2015	Spring/creek	Cylinder box in creek, trough (empty) downstream 200 ft. Basically a creek springing out of the ground.
Cowboy Spring 11		462853	4318087		None	8/12/2013		0.0938	6/12/2014	0.15	7/6/2015	Spring	Trampled, hard to determine flow
Cowboy Spring 12		464979	4317937					0.5093	6/4/2014	None	7/8/2015	Spring	Dry, may have been spring at one time due to vegetation
Cowboy Spring 13	M-SP39 (M)	466911	4318985	1.44 6/28/13			1.61 6/29/14	None	6/4/2014	None	6/24/2015	Seep	Trampled, we couldn't decide which springs matched up with last year's, so we made new spring names/waypoints. Outside of fenced area. In cluster with GRNHLWSP4and Cowboy Spring 14
Cowboy Spring 14	M-SP39 (M)	466916	4318981	1.44 6/28/13			1.61 6/29/14	1.1964	6/4/2014	0.88	6/24/2015	Spring	Cylinder contains spring, flow exits through a hole in cylinder- about 2 ft diameter. Not sure which waypoint referred to which springs, so we created new waypoints.
Cowboy Spring 15		464665	4317374							None	7/8/2015	Spring	Fencing around spring. Rough below and black pipe leading from spring to trough
Cowboy Spring 16		464614	4317948							0.11	7/29/2015	Spring	No development, elk wallow at bottom
Cowboy Pond		462393	4318314							None	7/6/2015	Pond	No development
Cowboy Trough/Spring	M-SP53 (M)	466304	4317351	0.091 6/28/13	0.08	7/30/2013	0.07 6/21/14	0.0735	6/2/2014	0.06	6/24/2015	Trough	There was a disconnect in the pipes leading to the trough, so the water was not reaching the trough.
Cowboy Spring 2		467027	4319014					1.1892	6/4/2014	None	6/24/2015	Spring	Piped water out of ground.
Clay Spring		464387	4320853		None	7/15/2013		None	6/9/2014	See Note	6/22/2015	Spring	Couldn't find any resemblance of a spring nearby. Replaced as Clay Spring 3
Clay Spring 1		463333	4319905					0.97357	6/10/2014	None	6/22/2015	Spring	Spring flows into a pond and to the side of pond
Clay Spring 2		463361	4320218					0.52918	6/16/2014	0.33	6/22/2015	Spring	A lot of small springs/seeps

Clay Spring 3		464509	4321149				None	6/9/2014	None	6/22/2015	Spring	Looked like it might have been a spring once upon a time, but now is completely dry. Wet recently?
Clay Spring 4		464013	4320609						0.26	7/8/2015	Spring	Spring box, with green and black piping, rough at the bottom
MSP 100	M-SP100	463555	4316929	1.076	6/5/04	----	0.7514	6/3/2014	0.35	7/22/2015	Spring	Trampled a little bit. Red waypoint on the GPS, not one on the spring map we got. Spring box, fencing, black pipe
Big Ridge Spring 1A		465560	4316155						0.13	7/29/2015	Spring	No development combined flow 1A & 1B
Big Ridge Spring 1B		465555	4316158						0.13	7/29/2015	Spring	No development combined flow 1A & 1B

(M) Currently Monitored by Sufco, if no (M) site was historically monitored and there is some data available

(FS) Forest Service monitoring

GREENS HOLLOW TRACT
ADJACENT AREA
UNDERGROUND WATER SAMPLING
ANALYSES AND AGE DATING
2015 AND 2016



SUFCO MINE UNDERGROUND WATER SAMPLING LOCATIONS FOR ANALYSIS AND AGE DATING 2015 AND 2016, GREENS HOLLOW TRACT

BYU *Laboratory of Isotope Geochemistry*
Department of Geological Sciences
BYU campus, Provo, Utah 84602
phone: (801) 422-3918

Client: Sufco Mine
397 South 800 West
Salina, UT 84526

Reporting Date: 16 AUG 2015

Project: Sufco Mine May 2015 Underground Samples

Radiocarbon Age Analysis

Sample ID	BYU ID	Sample Date	^{14}C (pmc)	+/- 1 σ	$\delta^{13}C$ (‰)	+/- 1 σ
XC51 2 South Bleeder	11963	6-May-15	28.31	0.10	-10.3	0.04
3 Right Bleeder	11964	6-May-15	12.15	0.06	-9.0	0.04
5 West #4 Entry R.D.	11965	6-May-15	9.00	0.05	-9.0	0.04

NOTES:

Pretreatment: Carbon was extracted from the water sample as barium carbonate precipitate. Carbon dioxide was recovered from the carbonate in a high-vacuum system for processing into benzene and isotopic analysis.

Comments: Percent modern carbon was calculated according to Stuvier, M. and Polach, HA, 1997, Discussion of ^{14}C data: Radiocarbon 19:355-63 by comparison against the activities of 4990C NBS oxalic acid and a total process blank. Based upon a Libby half life of 5568 years for ^{14}C.

David G. Tingey
Research Professor

BYU *Laboratory of Isotope Geochemistry*

Department of Geological Sciences

BYU campus, Provo, Utah 84602

Client: Sufco Mine
397 South 800 West
Salina, UT 84526

Reporting Date: 16 Aug 2015

Project: Sufco Mine May 2015 Underground Samples

Tritium Analysis

Sample ID	BYU ID	Sample Date	^{3}H (TU)	MDA*	Sample Preparation
XC51 2 South Bleeder	11963	6-May-15	5.2	0.3	Enriched
3 Right Bleeder	11964	6-May-15	4.0	0.3	Enriched
5 West #4 Entry R.D.	11965	6-May-15	3.6	0.3	Enriched

NOTES:

* Minimum Detectable Activity

Standardization was done using NIST Radioactivity Standard Reference Material SRM 436 1C Hydrogen-3.

Samples analyzed using a PerkinElmer 1220 Quantulus Ultra Low Level Liquid Scintillation Spectrometer after electrolytic Tritium enrichment. Average counting statistic for each sample is +/- 0.2 TU. Minimum detectable activity is a combination of the counting statistics, cosmic contributions, instrument noise and effects from LSC vials.

David G. Tingey
Research Professor

SGS

Analysis Report

September 23, 2015

CANYON FUEL CO SUFCO MINE
397 S 800 WEST
SALINA UT 84654

Client Sample ID:	5W #4 ENTRY ROOF DRIP	Sample ID By:	SUFCO
Date Sampled:	Sep 1, 2015	Sample Taken At:	5W #4 ENTRY ROOF DRIP
Date Received:	Sep 11, 2015	Sample Taken By:	EP
Product Description:	WATER	Time Sampled:	1300
		Time Received:	0900
		Mine:	25

Comments: Dissolved Metals Filtered at Lab. TDS expired when analyzed.

SGS Minerals Sample ID: 782-1530633-001

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
Alkalinity, mg CaCO3/L (pH 4.5)	259	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Carbonate Alkalinity as CaCO3	<5	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Bicarbonate Alkalinity as CaCO3	259	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Total Dissolved Solids	445	mg/L	SM2540-C	30	2015-09-14	15:00:00	MS
Chloride, Cl	12	mg/L	EPA 300.0	1	2015-09-16	07:36:00	HF
Sulfate, SO4	99	mg/L	EPA 300.0	1	2015-09-16	07:36:00	HF
METALS BY ICP							
Calcium, Ca - Dissolved	73.84	mg/L	EPA 200.7	0.03	2015-09-17	11:25:00	HF
Iron, Fe - Total	<0.05	mg/L	EPA 200.7	0.05	2015-09-15	12:00:00	HF
Iron, Fe - Dissolved	<0.03	mg/L	EPA 200.7	0.03	2015-09-17	11:25:00	HF
Magnesium, Mg - Dissolved	36.90	mg/L	EPA 200.7	0.01	2015-09-17	11:25:00	HF
Potassium, K - Dissolved	2.96	mg/L	EPA 200.7	0.14	2015-09-17	11:25:00	HF
Sodium, Na - Dissolved	17.06	mg/L	EPA 200.7	0.09	2015-09-17	11:25:00	HF

Domenic Ibanez
Lab Supervisor

SGS

Analysis Report

September 23, 2015

CANYON FUEL CO SUFCO MINE
397 S 800 WEST
SALINA UT 84654

Client Sample ID:	3R 2S BLEEDER	Sample ID By:	SUFCO
Date Sampled:	Sep 1, 2015	Sample Taken At:	3R 2S BLEEDER
Date Received:	Sep 11, 2015	Sample Taken By:	EP
Product Description:	WATER	Time Sampled:	1100
		Time Received:	900
		Mine:	25

Comments: Dissolved Metals Filtered at Lab. TDS expired when analyzed.

SGS Minerals Sample ID: 782-1530633-002

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
Alkalinity, mg CaCO3/L (pH 4.5)	250	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Carbonate Alkalinity as CaCO3	<5	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Bicarbonate Alkalinity as CaCO3	250	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Total Dissolved Solids	818	mg/L	SM2540-C	30	2015-09-14	15:00:00	MS
Chloride, Cl	14	mg/L	EPA 300.0	1	2015-09-16	07:36:00	DI
Sulfate, SO4	368	mg/L	EPA 300.0	1	2015-09-18	18:33:22	DI
METALS BY ICP							
Calcium, Ca - Dissolved	67.24	mg/L	EPA 200.7	0.03	2015-09-17	11:25:00	HF
Iron, Fe - Total	<0.05	mg/L	EPA 200.7	0.05	2015-09-15	12:00:00	HF
Iron, Fe - Dissolved	<0.03	mg/L	EPA 200.7	0.03	2015-09-17	11:25:00	HF
Magnesium, Mg - Dissolved	50.75	mg/L	EPA 200.7	0.01	2015-09-17	11:25:00	HF
Potassium, K - Dissolved	4.28	mg/L	EPA 200.7	0.14	2015-09-17	11:25:00	HF
Sodium, Na - Dissolved	130.93	mg/L	EPA 200.7	0.09	2015-09-17	11:25:00	HF

Domenic Ibanez
Lab Supervisor

SGS

Analysis Report

September 23, 2015

CANYON FUEL CO SUFCO MINE
397 S 800 WEST
SALINA UT 84654

Client Sample ID:	XC51 2 S BLEEDER	Sample ID By:	SUFCO
Date Sampled:	Sep 1, 2015	Sample Taken At:	XC51 2S BLEEDER
Date Received:	Sep 11, 2015	Sample Taken By:	EP
Product Description:	WATER	Time Sampled:	1000
		Time Received:	0900
		Mine:	25

Comments: Dissolved Metals Filtered at Lab. TDS expired when analyzed.

SGS Minerals Sample ID: 782-1530633-003

TESTS	RESULT	UNIT	METHOD	REPORTING LIMIT	ANALYZED DATE	ANALYZED TIME	ANALYST
Alkalinity, mg CaCO3/L (pH 4.5)	213	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Carbonate Alkalinity as CaCO3	<5	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Bicarbonate Alkalinity as CaCO3	213	mg/L	SM2320-B	5	2015-09-17	18:37:00	MS
Total Dissolved Solids	344	mg/L	SM2540-C	30	2015-09-14	15:00:00	MS
Chloride, Cl	12	mg/L	EPA 300.0	1	2015-09-16	07:36:00	HF
Sulfate, SO4	53	mg/L	EPA 300.0	1	2015-09-16	07:36:00	HF
METALS BY ICP							
Calcium, Ca - Dissolved	60.31	mg/L	EPA 200.7	0.03	2015-09-17	11:25:00	HF
Iron, Fe - Total	0.09	mg/L	EPA 200.7	0.05	2015-09-15	12:00:00	HF
Iron, Fe - Dissolved	<0.03	mg/L	EPA 200.7	0.03	2015-09-17	11:25:00	HF
Magnesium, Mg - Dissolved	27.11	mg/L	EPA 200.7	0.01	2015-09-17	11:25:00	HF
Potassium, K - Dissolved	1.73	mg/L	EPA 200.7	0.14	2015-09-17	11:25:00	HF
Sodium, Na - Dissolved	18.86	mg/L	EPA 200.7	0.09	2015-09-17	11:25:00	HF

Domenic Ibanez
Lab Supervisor

UNIVERSITY OF MIAMI

December 18, 2015

TRITIUM LABORATORY

Data Release #15-105
Job # 3331

PETERSEN HYDROLOGIC
TRITIUM SAMPLES

James Happell
Digitally signed by James Happell
DN: cn=James Happell, o=Univ. of Miami, ou=RSMAS, email=jhappell@rsmas.miami.edu, c=US
Date: 2015.12.18 15:11:26 -05'00'

Dr. James D. Happell
Associate Research Professor

Distribution:
Vicky Miller - Canyon Fuel
Erik C. Petersen - Petersen Hydrologic

GENERAL COMMENTS ON TRITIUM RESULTS

Tritium Scale New Half-life

Tritium concentrations are expressed in TU, where 1 TU indicates a T/H abundance ratio of 10^{-18}. The values refer to the tritium scale recommended by U.S. National Institute of Science and Technology (NIST, formerly NBS), and International Atomic Energy Agency (IAEA). The TU-numbers are based on the NIST tritium water standard #4926E. Age corrections and conversions are made using the recommended half-life of **12.32 years**, i.e., a decay rate of λ = 5.626% $year^{-1}$. In this scale, 1 TU is equivalent to 7.151 dpm/kg H_2O, or 3.222 pCi/kg H_2O, or 0.1192 Bq/kg H_2O (Bq = disint/sec).

TU values are calculated for date of sample collection, REFDATE in the table, as provided by the submitter. If no such date is available, date of sample arrival at our laboratory is used.

The stated errors, eTU, are one standard deviation (1 sigma) including all conceivable contributions. In the table, QUANT is quantity of sample received, and ELYS is the amount of water taken for electrolytic enrichment. DIR means direct run (no enrichment).

Remark: From 1 Jan 1994 through 31 Dec 2001 we used the previously recommended value for the half-life, 12.43 years. The use of the new number, 12.32 years will in practice increase the reported TU-values by 0.9 %. This is insignificant since our reported values carry 1 sigma uncertainties of 3 % or more.

It is interesting to note that before 1994 we used the older, then recommended value of 12.26 years.

Very low tritium values

In some cases, negative TU values are listed. Such numbers can occur because the net tritium count rate is, in principle the difference between the count rate of the sample and that of a tritium-free sample (background count or blank sample). Given a set of "unknown" samples with no tritium, the distribution of net results should become symmetrical around 0 TU. The negative values are reported as such for the benefit of allowing the user unbiased statistical treatment of sets of the data. For other applications, 0 TU should be used.

Additional information

Refer to Services Rendered (Tritium), Section II.8, in the "Tritium Laboratory Price Schedule; Procedures and Standards; Advice on Sampling", and our Web-site www.rsmas.edu/groups/tritium.

Tritium efficiencies and background values are somewhat different in each of the nine counters and values are corrected for cosmic intensity, gas pressure and other parameters. For tritium, the efficiency is typically 1.00 cpm per 100 TU (direct counting). At 50x enrichment, the efficiency is equivalent to 1.00 cpm per 2.4 TU. The background is typically 0.3 cpm, known to about $\pm$ 0.02 cpm. Our reported results include not only the Poisson statistics, but also other experimental uncertainties such as enrichment error, etc.

End

Client: PETERSEN HYDROLOGIC-SUFCO MINE   Bill to: Vicky Miller
Recvd : 15/09/11   Contact: E. Petersen, 801/766-4006
Job# : 3331   2695 N. 600 E.
Final : 15/12/16   Canyon Fuel Company, LLC   Lehi, UT 84043

Cust	LABEL INFO	JOB.SX	REFDATE	QUANT	ELYS	TU	eTU
PH	- XC51 2 S BLEEDER ROOF DRIP	3331.01	150901	1000	275	0.03	0.09
PH	- 3 RT 2 S BLEEDER GOB DRN	3331.02	150901	1000	275	0.05	0.09
PH	- 5TH W #4 ENTRY ROOF DRIP	3331.03	150901	1000	275	0.00*	0.09

* Average of duplicate runs

BYU *Laboratory of Isotope Geochemistry*
Department of Geological Sciences
BYU campus Provo, Utah 84602
phone: (801) 422-3918

Client: Ms. Vicky Miller
Canyon Fuel Company, LLC
Sufco Mine
397 South 800 West
Salina, UT 84526

Reporting Date: 3 July 2016

Project: Sufco Mine Samples

Radiocarbon Age Analysis

Sample ID	BYU ID	Sample Date	^{14}C (pmc)	+/- 1 σ	$\delta^{13}C$ (‰)	+/- 1 σ
XCS1 2 South Bleeder Roof Drip	12417	9/1/2015	28.39	0.11	-9.9	0.04
3 Right 2 South Bleeder Gob Drainage	12418	9/1/2015	24.2	0.1	-4.8	0.04
5th West #4 Entry Roof Drip	12419	9/1/2015	9.87	0.06	-8.9	0.04

NOTES:

Pretreatment: Carbon was extracted from the water sample as barium carbonate precipitate. Carbon dioxide was recovered from the carbonate in a high vacuum system for processing into benzene and isotopic analysis.

Comments: Percent modern carbon was calculated according to Stuiver, M. and Polach, HA. 1977. Discussion of ^{14}C data. Radiocarbon 19:355-63 by comparison against the activities of 4990C NIST oxalic acid and a total process blank. Based upon a Libby half-life of 5568 years for ^{14}C.

David G. Tingey
Research Professor

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Department of Geological Sciences
BYU campus, Provo, Utah 84602
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Client: Ms. Vicky Miller
Canyon Fuel Company, LLC
Sufco Mine
397 South 800 West
Salina, UT 84526

Reporting Date: 3 July 2016

Project: Sufco Mine Samples

Radiocarbon Age Analysis

Sample ID	BYU ID	Sample Date	^{14}C (pmc)	+/- 1 σ	$\delta^{13}C$ (‰)	+/- 1 σ
XC51 2 South Bleeder Roof Drip	12417	9/1/2015	28.39	0.11	9.9	0.04
3 Right 2 South Bleeder Gob Drainage	12418	9/1/2015	24.2	0.1	-4.8	0.04
5th West #4 Entry Roof Drip	12419	9/1/2015	9.87	0.06	8.9	0.04

NOTES:

Pretreatment: Carbon was extracted from the water sample as barium carbonate precipitate. Carbon dioxide was recovered from the carbonate in a high vacuum system for processing into benzene and isotope analysis.

Comments: Percent modern carbon was calculated according to Stuiver, M. and Polach, HA. 1997; Discussion of ^{14}C data. Radiocarbon 19:355-63 by comparison against the activities of 4990C NBS oxalic acid and a total process blank. Based upon a Libby half life of 5568 years for ^{14}C.

David G. Tingey
Research Professor

GREENS HOLLOW LEASE WATER MONITORING

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **South Fork Quitch. Upper**

SAMPLE DATE	11/11/2013	7/1/2014	09/25/2014	11/11/2014	07/29/2015	11/09/2015
Analysis*						
Field Water Temperature C	4.6	12.5	13.6	0.1	13.4	0.3
pH (field)	8.63	8.61	8.72	8.43	8.77	8.42
Dissolved Oxygen (field)	10	8.3	8.05	10.40	8.1	10.02
Sp. Conductivity (field)	514	515	518	593	497	503
Flow gpm	128	731	151.000	11.800	411.000	70.000
Hardness, mg equivalent CaCO3/L					255	
Acidity					<5	
Oil and Grease, (HEM)					<5	
Anions meq/L					5.3	
Balance %					2.58	
Cations meq/L					5.58	
Alkalinity, mg CaCO3/L (pH 4.5)					172	
Carbonate Alkalinity as CaCO3					<5	
Bicarbonate Alkalinity as CaCO3					172	
Nitrogen, Ammonia					<0.1	
Total Dissolved Solids					302	
Total Suspended Solids					24	
Nitrate					0.31	
Nitrite					<0.05	
Nitrate + Nitrate as Nitrogen					2.28	
Chloride, Cl					2	
Sulfate, SO4					87	
Ortho-Phosphate-P					<0.05	
Mercury, Hg - Dissolved µg/L					<0.2	
Phosphorus, Total					1.99	
Metals *						
Aluminum, Al - Total					0.27	
Aluminum, Al - Dissolved					<0.03	
Arsenic, As - Dissolved					<0.01	
Boron, B - Dissolved					0.04	
Barium, Ba - Dissolved					0.098	
Cadmium, Cd - Dissolved					<0.001	
Calcium, Ca - Total					51.07	
Calcium, Ca - Dissolved					48.34	
Chromium, Cr - Dissolved					<0.001	
Copper, Cu - Dissolved					<0.01	
Iron, Fe - Total					0.16	
Iron, Fe - Dissolved					<0.03	
Lead, Pb - Dissolved					<0.01	
Magnesium, Mg - Dissolved					32.62	
Manganese, Mn - Total					0.01	
Manganese, Mn - Dissolved					<0.002	
Molybdenum, Mo - Dissolved					<0.005	
Nickel, Ni - Dissolved					<0.001	
Potassium, K - Total					1.17	
Potassium, K - Dissolved					1.01	

Selenium, Se - Total	0.03
Selenium, Se - Dissolved	<0.02
Silver, Ag - Dissolved	<0.002
Sodium, Na - Total	10.65
Sodium, Na - Dissolved	10.65
Zinc, Zn - Dissolved	0.005

*units are in mg/L unless otherwise noted

NM = Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **U-Mud**

SAMPLE DATE	6/30/2014	9/18/2014	11/5/2014	6/26/2015	9/29/2015	10/28/2015
Analysis*						
Field Water Temperature C	13.0	13.2	1.6	14.8	11.4	3.6
pH (field)	8.78	8.72	8.7	8.78	8.72	8.65
Dissolved Oxygen (field)	8.17	8.26	9.97	8.31	8.21	9.86
Sp. Conductivity (field)	381	378	440	379	360	412
Flow CFS	63 cfs	19.4 cfs	11.6 cfs	60 cfs	16.3 cfs	9.04 cfs
Hardness, mg equivalent CaCO3/L	196	194	464	196	194	216
Acidity	<5	<5	<5	<5	<5	<5
Oil and Grease, (HEM)	<5	<5	<5	<5	<5	<5
Anions meq/L	4.15	4.06	12.89	3.89	4.02	4.28
Balance %	-0.22	1.56	4.00	3.68	2.23	4.67
Cations meq/L	4.13	4.19	13.96	4.19	4.2	4.7
Alkalinity, mg CaCO3/L (pH 4.5)	199	192	380	187	190	201
Carbonate Alkalinity as CaCO3	15	5	29	<5	<5	<5
Bicarbonate Alkalinity as CaCO3	184	187	351	187	190	201
Nitrogen, Ammonia	<0.1	0.2	<0.1	<0.1	<0.1	0.3
Total Dissolved Solids	199	198	820	217	220	255
Total Suspended Solids	16	<5	11	13	11	5
Nitrate	0.68	0.36	0.05	0.36	0.39	0.51
Nitrite	<0.05	<0.05	<0.05	<0.05	0.11	0.12
Nitrate + Nitrate as Nitrogen			0.05	0.33	2.3	0.63
Chloride, Cl	1	1	60	1	1	2
Sulfate, SO4	7	8	173	6	9	10
Ortho-Phosphate-P	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury, Hg - Dissolved µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phosphorus, Total	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Metals *						
Aluminum, Al - Total	0.20	0.14	0.17	0.09	0.08	0.12
Aluminum, Al - Dissolved	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Arsenic, As - Dissolved	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron, B - Dissolved	0.01	0.02	0.07	0.02	0.02	0.01
Barium, Ba - Dissolved	0.170	0.190	0.020	0.191	0.183	0.176
Cadmium, Cd - Dissolved	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium, Ca - Total	45.80	41.45	105.90	46.81	40.07	45.16
Calcium, Ca - Dissolved	42.00	40.17	98.05	41.01	37.67	45.16
Chromium, Cr - Dissolved	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, Cu - Dissolved	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, Fe - Total	0.12	0.11	0.36	0.05	0.06	0.11
Iron, Fe - Dissolved	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead, Pb - Dissolved	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium, Mg - Dissolved	22.00	22.76	53.30	22.70	24.26	25.04
Manganese, Mn - Total	0.006	0.007	0.018	0.009	0.003	0.003
Manganese, Mn - Dissolved	<0.002	<0.002	0.002	<0.002	<0.002	<0.002
Molybdenum, Mo - Dissolved	<0.005	<0.005	<0.002	<0.005	<0.005	<0.005
Nickel, Ni - Dissolved	0.002	<0.001	<0.001	<0.001	<0.001	0.002
Potassium, K - Total	<0.14	0.68	3.73	0.63	0.78	0.74
Potassium, K - Dissolved	0.55	0.68	3.57	0.63	0.67	0.74
Selenium, Se - Total	<0.02	<0.02	0.02	<0.02	<0.02	<0.02

Selenium, Se - Dissolved	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Silver, Ag - Dissolved	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Sodium, Na - Total	4.67	6.73	110.84	5.91	7.48	8.43
Sodium, Na - Dissolved	4.00	6.73	105.66	5.91	7.15	8.43
Zinc, Zn - Dissolved	<0.004	<0.004	<0.004	0.009	<0.004	0.005

ınits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # MSTR-6

SAMPLE DATE	6/7/2001	08/16/2001	09/25/2001	10/30/2001	04/17/2002	05/01/2002	06/05/2002	08/08/2002 & 9/24/2002	11/13/2002	03/11/2003 & 3/27/2003	05/07/2003	06/20/2003	08/06/2003 & 10/08/2003	02/21/2004 03/24/2004	05/11/2004	6/26/2015	9/28/2015	10/28/2015
Analysis*																		
Field Water Temperature C	20.10	12.4	11.5	2.7	9.6	8.2	23.3				11.7	12.6			15.4	22.3		
pH (field)	8.48	8.3	7.92	8.39	8.77	8.51	8.52				8.54	8.66			8.65	8.64		
Dissolved Oxygen (field)	6.54	7.13	3.14	8.73	7.16	8.55	5.13				7.01	8.15			6.59	5.43		
Sp. Conductivity (field)	808.00	439	575	448	462	819	569				490	822			723	968		
Flow gpm	16.85	4.7	1.9	6.438	18.165	4.455	3.020	NOF	NOF	NOA	17.836	3.024	NOF	NOA	27.400	0.636	NOF	NOF
Turbidity	67.50	81.4	30	11.6	9.63	8.32	40.9				8.29	12.8			96.3	NM		
Hardness, mg equivalent CaCO3/L											260.00				240			
Acidity											<5				<5			
Anions meq/L											8.80				8.3			
Balance %																		
Cations meq/L											8.80				8.6			
Alkalinity, mg CaCO3/L (pH 4.5)	351.00			391	373		350				360/369	341			368/370			
Carbonate Alkalinity as CaCO3	14.00			5	8		7				02/08	17			13-Nov			
Bicarbonate Alkalinity as CaCO3	400.00			477	439		412				430/433	381			420/422			
Nitrogen, Ammonia	<0.03										<0.2				<0.2			
Total Dissolved Solids	457.00			539	536		556				474.00	452			451	648		
Total Suspended Solids											25.00				42	680		
Nitrate + Nitrate as Nitrogen	<0.03			0.05			0.08				0.04/<0.03	<0.03			<0.03			
Chloride, Cl	40.00			43.1	40		53				31.00	39/44			21			
Sulfate, SO4	35.00			44.2	46		53				38.00	36/44			21			
Mercury, Hg - Dissolved µg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0004	<0.0004				<0.0002	<0.0002			<0.0002			
Phosphorus, Total	<0.05			0.06	0.05		0.14				0.03	0.05			0.08			
Metals*																		
Aluminum, Al - Total																		
Aluminum, Al - Dissolved	<0.03	0.05	0.05	<0.03	<0.07	0.07	0.04				<0.03	<0.03			<0.1			
Arsenic, As - Dissolved	0.00	0.0022	0.0025	<0.1		<0.1	<0.1				<0.1	0.0015			0.0016			
Boron, B - Dissolved											0.06				0.05			
Barium, Ba - Dissolved																		
Cadmium, Cd - Dissolved	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005	<0.0005				<0.0005	<0.0005			<0.005			
Calcium, Ca - Total	37.00			55	58		45				66.00	58			58			
Calcium, Ca - Dissolved											55.00				55			
Chromium, Cr - Dissolved	0.00	0.0051	0.006	<0.005		<0.005	<0.0005				0.01	<0.0005			<0.005			
Copper, Cu - Dissolved	0.00	<0.01	0.0019	<0.01		<0.01	<0.01				<0.01	<0.01			<0.01			
Iron, Fe - Total	1.10			0.3	0.4		0.8				0.54	0.31			1.4	5.67		
Iron, Fe - Dissolved											<0.02				<0.02			
Lead, Pb - Dissolved	<0.005	<0.005	<0.005	<0.005		<0.07	<0.07				0.07	<0.001			<0.07			
Magnesium, Mg - Total	33.00			38	32		34				31/36	40			25			
Manganese, Mn - Total											0.03				0.04	0.251		
Manganese, Mn - Dissolved											0.01				<0.01			
Molybdenum, Mo - Dissolved											<0.02				<0.02			
Nickel, Ni - Dissolved	0.00	0.0027	0.0037	<0.01	2	<0.01	<0.01				<0.01	<0.01			0.01			
Potassium, K - Total	2.00			3			4				3.20	3			4			
Potassium, K - Dissolved											2.70				2.8			
Selenium, Se - Total						0.0009					<0.1							
Selenium, Se - Dissolved	0.00	0.0011	0.0009	0.0008		<0.1	<0.1					0.0012			0.0014			
Silver, Ag - Dissolved	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005	<0.0005				<0.005	<0.005			<0.005			
Sodium, Na - Total	101.00			90	85		90				90.00	77			82			
Sodium, Na - Dissolved											80.00				85			
Zinc, Zn - Dissolved	0.01	0.01	0.01	0.01		0.01	0.01				<0.01	<0.01			0.02			
Cyanide- Dissolved	<0.002	0.015	<0.002	<0.002		<0.002	<0.002				0.01	<0.002			<0.002			
Orthophosphate	<0.05										<0.05	<0.05			<0.05			

*units are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # MSP-4

SAMPLE DATE	06/19/2001	08/28/2001	05/03/2002	09/26/2002	11/12/2002	05/20/2003	08/05/2003	10/06/2003	05/12/2004	8/26/2015	9/30/2015	11/1/2015
Analysis*												
Field Water Temperature C	5.6	4.7	4.5	5.3	4.8	4.2	5.4	5.4	4.4	4.9	8.0	5.5
pH (field)	8.05	7.73	7.61	7.41	7.56	7.38	7.40	7.50	7.59	7.68	7.89	7.72
Dissolved Oxygen (field)	NM	NM	NM	0.21	6.64	7.69	7.40	7.30	0.69	NM	NM	NM
Sp. Conductivity (field)	499	379	866	844	885	929	408	861	512	986	872	873
Flow gpm	2.838	1.832	2.043	0.900	1.230	3.226	0.849	0.747	2.921	1.81	0.251	0.638
Turbidity	0.62	0.47	0.00	0.91	5.40	0.00	0.10	1.02	0.69	NM	NM	NM
Hardness, mg equivalent CaCO3/L												
Acidity												
Anions meq/L												
Balance %												
Cations meq/L												
Alkalinity, mg CaCO3/L (pH 4.5)												
Carbonate Alkalinity as CaCO3												
Bicarbonate Alkalinity as CaCO3												
Nitrogen, Ammonia												
Total Dissolved Solids										590	550	517
Total Suspended Solids										38	152	109
Nitrate + Nitrate as Nitrogen												
Chloride, Cl												
Sulfate, SO4												
Mercury, Hg - Dissolved µg/L												
Phosphorus, Total												
Metals *												
Aluminum, Al - Total												
Aluminum, Al - Dissolved												
Arsenic, As - Dissolved												
Boron, B - Dissolved												
Barium, Ba - Dissolved												
Cadmium, Cd - Dissolved												
Calcium, Ca - Total												
Calcium, Ca - Dissolved												
Chromium, Cr - Dissolved												
Copper, Cu - Dissolved												
Iron, Fe - Total										0.14	0.46	0.37
Iron, Fe - Dissolved												
Lead, Pb - Dissolved												
Magnesium, Mg - Dissolved												
Manganese, Mn - Total										0.007	0.044	0.018
Manganese, Mn - Dissolved												
Molybdenum, Mo - Dissolved												
Nickel, Ni - Dissolved												
Potassium, K - Total												
Potassium, K - Dissolved												
Selenium, Se - Total												
Selenium, Se - Dissolved												
Silver, Ag - Dissolved												
Sodium, Na - Total												
Sodium, Na - Dissolved												
Zinc, Zn - Dissolved												

*units are in mg/L unless otherwise noted

NM = Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **MSP-5**

SAMPLE DATE	09/26/2002	06/20/2003	09/25/2003	05/12/2004	6/26/2015	9/30/2015	11/1/2015
Analysis*							
Field Water Temperature C	7.7	4.3	7.3	3.9	7.8	8.9	6.6
pH (field)	7.77	7.60	7.78	7.92	7.8	7.91	7.84
Sp. Conductivity (field)	780	910	533	524	934	870	888
Flow gpm	0.082	0.216	0.119	0.264	0.127	0.085	0.157
Turbidity	19.00	0.35	17.70	0.16	NM	NM	NM
Hardness, mg equivalent CaCO3/L							
Acidity							
Anions meq/L							
Balance %							
Cations meq/L							
Alkalinity, mg CaCO3/L (pH 4.5)							
Carbonate Alkalinity as CaCO3							
Bicarbonate Alkalinity as CaCO3							
Nitrogen, Ammonia							
Total Dissolved Solids					577	561	548
Total Suspended Solids					34	115	93
Nitrate + Nitrate as Nitrogen							
Chloride, Cl							
Sulfate, SO4							
Mercury, Hg - Dissolved µg/L							
Phosphorus, Total							
Metals *							
Aluminum, Al - Total							
Aluminum, Al - Dissolved							
Arsenic, As - Dissolved							
Boron, B - Dissolved							
Barium, Ba - Dissolved							
Cadmium, Cd - Dissolved							
Calcium, Ca - Total							
Calcium, Ca - Dissolved							
Chromium, Cr - Dissolved							
Copper, Cu - Dissolved							
Iron, Fe - Total					0.41	0.38	0.83
Iron, Fe - Dissolved							
Lead, Pb - Dissolved							
Magnesium, Mg - Dissolved							
Manganese, Mn - Total					0.027	0.078	0.073
Manganese, Mn - Dissolved							
Molybdenum, Mo - Dissolved							
Nickel, Ni - Dissolved							
Potassium, K - Total							
Potassium, K - Dissolved							
Selenium, Se - Total							
Selenium, Se - Dissolved							
Silver, Ag - Dissolved							
Sodium, Na - Total							
Sodium, Na - Dissolved							
Zinc, Zn - Dissolved							

*units are in mg/L unless otherwise noted

NM = Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # MSP-6

SAMPLE DATE	06/19/2001	10/04/2001	05/03/2002	09/26/2002	5/20/2003	9/25/2003	5/12/2004	6/26/2015	9/29/2015	11/1/2015
Analysis*										
Field Water Temperature C	9.30	6.30	4.90	5.4	4.6	5.3	4.7	5.5	5.8	5.5
pH (field)	9	8	9	7.55	7.62	7.59	7.78	7.82	7.68	7.77
Sp. Conductivity (field)	550	474	899	895	918	514	528	932	868	887
Flow gpm	2.30	1.66	2.06	1.549	1.472	1.665	1.624	1.45	1.34	1.23
Turbidity	7.5	13.2	0.88	0	1.24	0	0.05	NM	NM	NM
Hardness, mg equivalent CaCO3/L								137	133	133
Acidity								<5	10	<5
Anions meq/L								10.11	9.68	10.27
Balance %								-0.66	3.49	-0.35
Cations meq/L								9.98	10.38	10.2
Alkalinity, mg CaCO3/L (pH 4.5)								469	452	478
Carbonate Alkalinity as CaCO3								<5	<5	<5
Bicarbonate Alkalinity as CaCO3								469	452	478
Nitrogen, Ammonia								<0.1	<0.1	<0.1
Total Dissolved Solids								557	559	542
Total Suspended Solids								11	9	25
Nitrate								0.13	0.17	0.16
Nitrite								<0.05	<0.05	<0.05
Nitrate + Nitrate as Nitrogen								0.14	1.43	0.9
Chloride, Cl								15	12	15
Sulfate, SO4								15	15	15
Mercury, Hg - Dissolved µg/L								<0.05	<0.05	<0.05
Phosphorus, Total								<0.2	<0.2	<0.2
								0.07	<0.05	<0.05
Metals *										
Aluminum, Al - Total								0.19	0.08	0.15
Aluminum, Al - Dissolved								<0.03	<0.03	<0.03
Arsenic, As - Dissolved								<0.01	<0.01	<0.01
Boron, B - Dissolved								0.06	0.06	0.05
Barium, Ba - Dissolved								0.191	0.187	0.186
Cadmium, Cd - Dissolved								<0.001	<0.001	<0.001
Calcium, Ca - Total								34.72	26.81	27.14
Calcium, Ca - Dissolved								25.6	26.1	26.4
Chromium, Cr - Dissolved								<0.001	<0.001	<0.001
Copper, Cu - Dissolved								<0.01	<0.01	<0.01
Iron, Fe - Total								0.17	<0.05	0.1
Iron, Fe - Dissolved								<0.03	<0.03	<0.03
Lead, Pb - Dissolved								<0.01	<0.01	<0.01
Magnesium, Mg - Dissolved								17.69	16.59	16.31
Manganese, Mn - Total								0.032	0.002	0.008
Manganese, Mn - Dissolved								<0.002	<0.002	<0.002
Molybdenum, Mo - Dissolved								<0.005	<0.005	<0.005
Nickel, Ni - Dissolved								<0.001	<0.001	<0.001
Potassium, K - Total								1.28	1.31	1.44
Potassium, K - Dissolved								1.28	1.26	1.44
Selenium, Se - Total								<0.02	<0.02	<0.02
Selenium, Se - Dissolved								<0.02	<0.02	<0.02
Silver, Ag - Dissolved								<0.002	<0.002	<0.002
Sodium, Na - Total								168.64	201.34	173.22
Sodium, Na - Dissolved								165.88	176.66	172.56
Zinc, Zn - Dissolved								0.01	<0.004	<0.004

* units are in mg/L unless otherwise note

NM = Not Meausred

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **MSP-09**

SAMPLE DATE	6/20/2001	8/29/2001	5/3/2002	9/26/2002	5/20/2003	10/7/2003	5/10/2004	6/25/2015	9/26/2015	11/1/2015
Analysis*										
Field Water Temperature C	7.9		3.6							
pH (field)	7.53		8.55							
Sp. Conductivity (field)	464		429							
Flow gpm	1.000	NOF	0.254	NOF	NOF	NOF	NOF	NOF	NOF	NOF
Turbidity	1.43		141.00							
Hardness, mg equivalent CaCO3/L										
Acidity										
Anions meq/L										
Balance %										
Cations meq/L										
Alkalinity, mg CaCO3/L (pH 4.5)										
Carbonate Alkalinity as CaCO3										
Bicarbonate Alkalinity as CaCO3										
Nitrogen, Ammonia										
Total Dissolved Solids										
Total Suspended Solids										
Nitrate + Nitrate as Nitrogen										
Chloride, Cl										
Sulfate, SO4										
Mercury, Hg - Dissolved µg/L										
Phosphorus, Total										
Metals*										
Aluminum, Al - Total										
Aluminum, Al - Dissolved										
Arsenic, As - Dissolved										
Boron, B - Dissolved										
Barium, Ba - Dissolved										
Cadmium, Cd - Dissolved										
Calcium, Ca - Total										
Calcium, Ca - Dissolved										
Chromium, Cr - Dissolved										
Copper, Cu - Dissolved										
Iron, Fe - Total										
Iron, Fe - Dissolved										
Lead, Pb - Dissolved										
Magnesium, Mg - Dissolved										
Manganese, Mn - Total										
Manganese, Mn - Dissolved										
Molybdenum, Mo - Dissolved										
Nickel, Ni - Dissolved										
Potassium, K - Total										
Potassium, K - Dissolved										
Selenium, Se - Total										
Selenium, Se - Dissolved										
Silver, Ag - Dissolved										
Sodium, Na - Total										
Sodium, Na - Dissolved										
Zinc, Zn - Dissolved										

Units are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **M-SP15**

SAMPLE ID: -

SAMPLE DATE	7/11/2001	10/3/2001	5/2/2002	9/27/2002	5/21/2003	10/8/2003	6/5/2004	6/27/2015	9/29/2015	11/7/2015
Analysis*										
Field Water Temperature C	13.5	6.4	5.4		14.9		15.5	12.9		
pH (field)	8.26	8.34	7.70		7.65		8.14	7.42		
Sp. Conductivity (field)	621	433	448	NOF	509	NOF	930	1073		
Flow gpm	4.822	1.733	0.548		0.433		0.268	0.059	DRY	DRY
Turbidity	69.90	3.68	0.00		14.07		2.52	NM		
Hardness, mg equivalent CaCO3/L										
Acidity										
Anions meq/L										
Balance %										
Cations meq/L										
Alkalinity, mg CaCO3/L (pH 4.5)										
Carbonate Alkalinity as CaCO3										
Bicarbonate Alkalinity as CaCO3										
Nitrogen, Ammonia										
Total Dissolved Solids								528		
Total Suspended Solids								31		
Nitrate										
Nitrite										
Nitrate + Nitrite as Nitrogen										
Chloride, Cl										
Sulfate, SO4										
Ortho-Phosphate-P										
Mercury, Hg - Dissolved µg/L										
Phosphorus, Total										
Metals *										
Aluminum, Al - Total										
Aluminum, Al - Dissolved										
Arsenic, As - Dissolved										
Boron, B - Dissolved										
Barium, Ba - Dissolved										
Cadmium, Cd - Dissolved										
Calcium, Ca - Total										
Calcium, Ca - Dissolved										
Chromium, Cr - Dissolved										
Copper, Cu - Dissolved										
Iron, Fe - Total								0.29		
Iron, Fe - Dissolved										
Lead, Pb - Dissolved										
Magnesium, Mg - Dissolved										
Manganese, Mn - Total								0.046		
Manganese, Mn - Dissolved										
Molybdenum, Mo - Dissolved										
Nickel, Ni - Dissolved										
Potassium, K - Total										
Potassium, K - Dissolved										
Selenium, Se - Total										
Selenium, Se - Dissolved										
Silver, Ag - Dissolved										
Sodium, Na - Total										
Sodium, Na - Dissolved										
Zinc, Zn - Dissolved										

*units are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # M-SP19

SAMPLE DATE	7/11/2001	10/3/2001	5/2/2002	9/27/2002	5/21/2003	10/8/2003	6/5/2004	6/27/2015	9/29/2015	11/7/2015
Analysis*										
Field Water Temperature C	10.4	6.1	5.1	5.8	5.2	6.1	6.5	873	6.3	6
pH (field)	8.24	7.83	8.28	7.94	7.86	8.21	8.23	7.97	8.04	7.98
Sp. Conductivity (field)	508	443	456	457	449	480	851	5.7	824	829
Flow gpm	2.260	1.976	3.031	2.114	2.866	2.555	3.128	2.56	1.73	1.95
Turbidity	5.90	0.17	0.46	0.35	12.30	0.08	1.34	NM	NM	NM
Hardness, mg equivalent CaCO3/L										
Acidity										
Anions meq/L										
Balance %										
Cations meq/L										
Alkalinity, mg CaCO3/L (pH 4.5)										
Carbonate Alkalinity as CaCO3										
Bicarbonate Alkalinity as CaCO3										
Nitrogen, Ammonia										
Total Dissolved Solids								522	523	519
Total Suspended Solids								40	12	16
Nitrate										
Nitrite										
Nitrate + Nitrite as Nitrogen										
Chloride, Cl										
Sulfate, SO4										
Ortho-Phosphate-P										
Mercury, Hg - Dissolved µg/L										
Phosphorus, Total										
Metals*										
Aluminum, Al - Total										
Aluminum, Al - Dissolved										
Arsenic, As - Dissolved										
Boron, B - Dissolved										
Barium, Ba - Dissolved										
Cadmium, Cd - Dissolved										
Calcium, Ca - Total										
Calcium, Ca - Dissolved										
Chromium, Cr - Dissolved										
Copper, Cu - Dissolved										
Iron, Fe - Total								0.36	0.27	0.11
Iron, Fe - Dissolved										
Lead, Pb - Dissolved										
Magnesium, Mg - Dissolved										
Manganese, Mn - Total								0.044	0.004	0.004
Manganese, Mn - Dissolved										
Molybdenum, Mo - Dissolved										
Nickel, Ni - Dissolved										
Potassium, K - Total										
Potassium, K - Dissolved										
Selenium, Se - Total										
Selenium, Se - Dissolved										
Silver, Ag - Dissolved										
Sodium, Na - Total										
Sodium, Na - Dissolved										
Zinc, Zn - Dissolved										

*Units are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **MSP-20**

SAMPLE DATE	7/11/2001	10/3/2001	5/2/2002	9/28/2002	5/22/2003	10/8/2003	6/5/2004	6/25/2015	9/26/2015	11/1/2015
Analysis[1]										
Field Water Temperature C	14.2	12.1	10.5	7.4	7.6	11.0	10.8	8.3	7.5	6.6
pH (field)	7.64	7.85	7.97	7.79	7.59	8.31	7.92	7.78	7.38	7.69
Sp. Conductivity (field)	468	435	432	435	420	494	814	824	769	763
Flow gpm	3.507	0.909	0.814	0.706	1.041	0.781	8.621	5.24	1.04	1.21
Turbidity	3.52	5.20	0.00	20.00	19.05	18.80	0.35	NM	NM	NM
Hardness, mg equivalent CaCO3/L										
Acidity										
Anions meq/L										
Balance %										
Cations meq/L										
Alkalinity, mg CaCO3/L (pH 4.5)										
Carbonate Alkalinity as CaCO3										
Bicarbonate Alkalinity as CaCO3										
Nitrogen, Ammonia										
Total Dissolved Solids								468	505	463
Total Suspended Solids								13	87	23
Nitrate + Nitrate as Nitrogen										
Chloride, Cl										
Sulfate, SO4										
Mercury, Hg - Dissolved µg/L										
Phosphorus, Total										
Metals[2]										
Aluminum, Al - Total										
Aluminum, Al - Dissolved										
Arsenic, As - Dissolved										
Boron, B - Dissolved										
Barium, Ba - Dissolved										
Cadmium, Cd - Dissolved										
Calcium, Ca - Total										
Calcium, Ca - Dissolved										
Chromium, Cr - Dissolved										
Copper, Cu - Dissolved										
Iron, Fe - Total								0.15	0.37	0.85
Iron, Fe - Dissolved										
Lead, Pb - Dissolved										
Magnesium, Mg - Dissolved										
Manganese, Mn - Total								0.016	0.049	0.042
Manganese, Mn - Dissolved										
Molybdenum, Mo - Dissolved										
Nickel, Ni - Dissolved										
Potassium, K - Total										
Potassium, K - Dissolved										
Selenium, Se - Total										
Selenium, Se - Dissolved										
Silver, Ag - Dissolved										
Sodium, Na - Total										
Sodium, Na - Dissolved										
Zinc, Zn - Dissolved										

nits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **MSP-40**

SAMPLE DATE	9/26/2001	5/2/2002	9/28/2002	5/22/2003	10/9/2003	6/6/2004	6/25/2015	9/26/2015	11/1/2015
Analysis*									
Field Water Temperature C	7.9	7.5	8.4	6.9	8.3	7.7	7.4	9.5	8
pH (field)	7.64	7.92	7.72	7.77	7.76	8.10	7.82	7.77	7.78
Sp. Conductivity (field)	497	865	483	538	900	545	959	905	925
Flow gpm	0.657	0.455	0.336	0.314	0.180	0.447	0.102	0.082	0.093
Turbidity	30.40	11.60	0.70	15.03	19.00	0.68	NM	NM	NM
Hardness, mg equivalent CaCO3/L									
Acidity									
Anions meq/L									
Balance %									
Cations meq/L									
Alkalinity, mg CaCO3/L (pH 4.5)									
Carbonate Alkalinity as CaCO3									
Bicarbonate Alkalinity as CaCO3									
Nitrogen, Ammonia									
Total Dissolved Solids							584	598	554
Total Suspended Solids							283	337	218
Nitrate + Nitrate as Nitrogen									
Chloride, Cl									
Sulfate, SO4									
Mercury, Hg - Dissolved µg/L									
Phosphorus, Total									
Metals *									
Aluminum, Al - Total									
Aluminum, Al - Dissolved									
Arsenic, As - Dissolved									
Boron, B - Dissolved									
Barium, Ba - Dissolved									
Cadmium, Cd - Dissolved									
Calcium, Ca - Total									
Calcium, Ca - Dissolved									
Chromium, Cr - Dissolved									
Copper, Cu - Dissolved									
Iron, Fe - Total							3.43	1.13	0.87
Iron, Fe - Dissolved									
Lead, Pb - Dissolved									
Magnesium, Mg - Dissolved									
Manganese, Mn - Total							0.228	0.253	0.076
Manganese, Mn - Dissolved									
Molybdenum, Mo - Dissolved									
Nickel, Ni - Dissolved									
Potassium, K - Total									
Potassium, K - Dissolved									
Selenium, Se - Total									
Selenium, Se - Dissolved									
Silver, Ag - Dissolved									
Sodium, Na - Total									
Sodium, Na - Dissolved									
Zinc, Zn - Dissolved									

nits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **MSP-41**

SAMPLE DATE	9/26/2001	5/2/2002	9/28/2002	5/22/2003	10/9/2003	6/6/2004	6/25/2015	9/26/2015	11/1/2015
Analysis*									
Field Water Temperature C	5.3	10.2	5.1	3.9	4.9	6.0	9.7	5.9	5
pH (field)	7.85	8.53	7.97	7.99	7.67	8.14	7.52	7.94	7.87
Sp. Conductivity (field)	285	616	323	429	799	452	897	765	789
Flow gpm	0.422	2.253	0.427	0.472	0.402	0.509	0.974	0.313	0.321
Turbidity	1.25	26.90	4.50	24.03	0.86	0.48	NM	NM	NM
Hardness, mg equivalent CaCO3/L									
Acidity									
Anions meq/L									
Balance %									
Cations meq/L									
Alkalinity, mg CaCO3/L (pH 4.5)									
Carbonate Alkalinity as CaCO3									
Bicarbonate Alkalinity as CaCO3									
Nitrogen, Ammonia									
Total Dissolved Solids							952	521	479
Total Suspended Solids							28	435	60
Nitrate + Nitrate as Nitrogen									
Chloride, Cl									
Sulfate, SO4									
Mercury, Hg - Dissolved µg/L									
Phosphorus, Total									
Metals*									
Aluminum, Al - Total									
Aluminum, Al - Dissolved									
Arsenic, As - Dissolved									
Boron, B - Dissolved									
Barium, Ba - Dissolved									
Cadmium, Cd - Dissolved									
Calcium, Ca - Total									
Calcium, Ca - Dissolved									
Chromium, Cr - Dissolved									
Copper, Cu - Dissolved									
Iron, Fe - Total							0.18	1.1	0.68
Iron, Fe - Dissolved									
Lead, Pb - Dissolved									
Magnesium, Mg - Dissolved									
Manganese, Mn - Total							0.031	0.111	0.016
Manganese, Mn - Dissolved									
Molybdenum, Mo - Dissolved									
Nickel, Ni - Dissolved									
Potassium, K - Total									
Potassium, K - Dissolved									
Selenium, Se - Total									
Selenium, Se - Dissolved									
Silver, Ag - Dissolved									
Sodium, Na - Total									
Sodium, Na - Dissolved									
Zinc, Zn - Dissolved									

inits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # M-SP44

SAMPLE DATE	10/3/2001	5/2/2002	9/28/2002	5/22/2003	9/24/2003	6/5/2004	6/29/2014	9/18/2014	10/31/2014	6/25/2015	9/26/2015	11/1/2015
Analysis*												
Field Water Temperature C	9.2	4.8	10.3	6.1	12.1	5.4	5.9	5.9	5.2	6	9.2	8.3
pH (field)	7.52	7.66	7.66	7.65	7.93	7.65	7.64	7.76	7.78	7.67	7.54	7.59
Sp. Conductivity (field)	314	269	376	276	721	542	554	922	934	570	581	594
Flow gpm	0.561	2.018	0.196	13.029	0.197	4.900	3.16	1.46	1.33	4.21	0.493	0.45
Turbidity	5.39	0.00	110.00	11.91	15.30	0.00	NM	NM	NM	NM	NM	NM
Hardness, mg equivalent CaCO3/L							298	259	261	303	267	270
Acidity							8	<5	12	7	5	<5
Anions meq/L							6.12	6.49	6.66	6.26	6.35	6.76
Balance %							3.85	-0.87	-2.11	1.93	2.49	1.5
Cations meq/L							6.61	6.38	6.38	6.50	6.67	6.97
Alkalinity, mg CaCO3/L (pH 4.5)							283	296	304	297	297	306
Carbonate Alkalinity as CaCO3							<5	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as CaCO3							283	296	304	297	297	306
Nitrogen, Ammonia							0.1	<0.1	0.1	<0.1	0.3	0.9
Total Dissolved Solids							313	340	358	346	367	365
Total Suspended Solids								26	27	37		14
Nitrate								0.24	0.06	0.16	0.06	0.12
Nitrite								<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate + Nitrate as Nitrogen							0.34		<0.05	0.14	0.29	0.86
Chloride, Cl							1	2	2	1	1	2
Sulfate, SO4							19	25	26	14	18	26
Ortho Phosphate-P							<0.05	<0.05	<0.05	<0.05	<0.05	0.06
Mercury, Hg - Dissolved µg/L							<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phosphorus, Total							<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Metals *												
Aluminum, Al - Total							<0.03	0.33	0.24	0.48	0.2	0.21
Aluminum, Al - Dissolved							<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Arsenic, As - Dissolved							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron, B - Dissolved							0.02	0.02	<0.01	0.02	0.02	0.02
Barium, Ba - Dissolved							0.358	0.340	0.342	0.407	0.341	0.347
Cadmium, Cd - Dissolved							<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium, Ca - Total							78.17	67.67	66.73	87.83	66.25	65.95
Calcium, Ca - Dissolved							66.00	64.82	63.52	68.47	63.37	65.95
Chromium, Cr - Dissolved							<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, Cu - Dissolved							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, Fe - Total							<0.05	0.22	0.12	0.34	0.12	0.13
Iron, Fe - Dissolved							<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead, Pb - Dissolved							<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium, Mg - Dissolved							33.00	23.48	24.9	32.10	28.32	25.55
Manganese, Mn - Total							<0.002	0.010	0.010	0.046	0.006	0.005
Manganese, Mn - Dissolved							<0.002	<0.002	0.002	<0.002	<0.002	<0.002
Molybdenum, Mo - Dissolved							<0.005	<0.005	<0.005	<0.005	0.006	0.006
Nickel, Ni - Dissolved							0.001	<0.001	<0.001	<0.001	0.002	<0.001
Potassium, K - Total							<0.14	0.56	0.69	0.57	0.6	0.64
Potassium, K - Dissolved							0.48	0.56	0.69	0.57	<0.14	0.64
Selenium, Se - Total							<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium, Se - Dissolved							<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Silver, Ag - Dissolved							<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Sodium, Na - Total							15.00	28.25	26.96	9.94	32.95	36.15
Sodium, Na - Dissolved							15.00	27.48	26.29	9.94	30.97	35.83
Zinc, Zn - Dissolved							<0.004	<0.004	<0.004	0.004	<0.004	<0.004

*units are in mg/L unless otherwise noted

NM- Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **MSP-45**

SAMPLE DATE	10/4/2001	5/3/2002	9/25/2002	5/21/2003	9/27/2003	6/3/2004	6/26/2015	9/30/2015	11/6/2015
Analysis*									
Field Water Temperature C	5.9	3.5	6.0	3.7	5.9	5.0	5.1	6.5	5.9
pH (field)	7.32	7.85	7.58	7.30	7.30	7.42	7.47	7.47	7.38
Sp. Conductivity (field)	508	969	977	977	545	369	996	923	933
Flow gpm	2.230	1.837	1.713	1.824	1.541	0.673	1.26	1.21	1.21
Turbidity	0.60	0.00	0.00	1.67	0.29	1.08	NM	NM	NM
Hardness, mg equivalent CaCO3/L									
Acidity									
Anions meq/L									
Balance %									
Cations meq/L									
Alkalinity, mg CaCO3/L (pH 4.5)									
Carbonate Alkalinity as CaCO3									
Bicarbonate Alkalinity as CaCO3									
Nitrogen, Ammonia									
Total Dissolved Solids							594	580	586
Total Suspended Solids							<5	34	25
Nitrate + Nitrate as Nitrogen									
Chloride, Cl									
Sulfate, SO4									
Mercury, Hg - Dissolved µg/L									
Phosphorus, Total									
Metals *									
Aluminum, Al - Total									
Aluminum, Al - Dissolved									
Arsenic, As - Dissolved									
Boron, B - Dissolved									
Barium, Ba - Dissolved									
Cadmium, Cd - Dissolved									
Calcium, Ca - Total									
Calcium, Ca - Dissolved									
Chromium, Cr - Dissolved									
Copper, Cu - Dissolved									
Iron, Fe - Total							<0.05	0.34	0.3
Iron, Fe - Dissolved									
Lead, Pb - Dissolved									
Magnesium, Mg - Dissolved									
Manganese, Mn - Total							<0.002	0.005	0.006
Manganese, Mn - Dissolved									
Molybdenum, Mo - Dissolved									
Nickel, Ni - Dissolved									
Potassium, K - Total									
Potassium, K - Dissolved									
Selenium, Se - Total									
Selenium, Se - Dissolved									
Silver, Ag - Dissolved									
Sodium, Na - Total									
Sodium, Na - Dissolved									
Zinc, Zn - Dissolved									

units are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **M-SP60**

SAMPLE DATE	5/2/2002	9/27/2002	5/21/2003	10/8/2003	6/4/2004	6/30/2014	9/23/2014	11/6/2014	5/27/2015	9/29/2015	11/7/2015
Analysis*											
Field Water Temperature C	5.7	8.0	6.5	7.8	9.6	11.5	8.4	6.9	6.9	8.5	6.7
pH (field)	7.64	7.52	7.63	7.63	7.79	7.68	7.67	7.61	7.61	7.8	7.47
Sp. Conductivity (field)	403	512	491	428	943	931	935	932	980	876	893
Flow gpm	0.688	0.728	0.761	0.600	0.676	0.72	0.57	0.56	0.545	0.348	0.39
Turbidity	5.70	0.10	14.25	0.81	0.76	NM	NM	NM	NM	NM	NM
Hardness, mg equivalent CaCO3/L						299		325	312	308	300
Acidity						<5		8	<5	<5	<5
Anions meq/L						10.45		10.06	9.97	10.03	10.3
Balance %						-2.77		3.06	1.58	2.01	-1.06
Cations meq/L						9.88		10.70	10.29	10.44	10.8
Alkalinity, mg CaCO3/L (pH 4.5)						439		421	416	425	435
Carbonate Alkalinity as CaCO3						<5		<5	<5	<5	<5
Bicarbonate Alkalinity as CaCO3						439		421	416	425	435
Nitrogen, Ammonia						<0.1		<0.1	<0.1	0.3	0.1
Total Dissolved Solids						513		507	536	552	535
Total Suspended Solids								13		23	93
Nitrate						0.16		0.13	0.11	0.17	0.3
Nitrite						<0.05		<0.05	<0.05	0.39	0.32
Nitrate + Nitrite as Nitrogen								<0.05	2.76	1.36	1.41
Chloride, Cl						39		39	39	36	38
Sulfate, SO4						27		26	26	25	25
Ortho-Phosphate-P						<0.05		<0.05	<0.05	<0.05	<0.05
Mercury, Hg - Dissolved µg/L						<0.2		<0.2	<0.2	<0.2	<0.2
Phosphorus, Total						<0.05		<0.05	<0.05	<0.05	0.08
Metals *											
Aluminum, Al - Total						0.14		0.05	0.23	0.91	0.89
Aluminum, Al - Dissolved						<0.03		<0.03	<0.03	0.03	<0.03
Arsenic, As - Dissolved						<0.01		<0.01	<0.01	<0.01	<0.01
Boron, B - Dissolved						0.07		0.12	0.05	0.07	0.06
Barium, Ba - Dissolved						0.263		0.297	0.034	0.281	0.252
Cadmium, Cd - Dissolved						<0.001		<0.001	<0.001	<0.001	<0.001
Calcium, Ca - Total						59.76		61.05	58.73	69.87	68.5
Calcium, Ca - Dissolved						54.00		61.05	52.98	53.87	54.05
Chromium, Cr - Dissolved						<0.001		<0.001	0.009	<0.001	<0.001
Copper, Cu - Dissolved						<0.01		<0.01	<0.01	<0.01	<0.01
Iron, Fe - Total						0.08		<0.05	0.14	0.55	0.58
Iron, Fe - Dissolved						<0.03		<0.03	0.04	<0.03	<0.03
Lead, Pb - Dissolved						<0.01		<0.01	<0.01	<0.01	<0.01
Magnesium, Mg - Dissolved						40.00		41.92	43.64	41.74	39.98
Manganese, Mn - Total						0.007		0.002	0.017	0.043	0.039
Manganese, Mn - Dissolved						<0.002		<0.002	0.004	<0.002	<0.002
Molybdenum, Mo - Dissolved						<0.005		<0.005	0.018	<0.005	<0.005
Nickel, Ni - Dissolved						0.001		<0.001	0.002	<0.001	0.001
Potassium, K - Total						2.00		1.74	1.76	2.14	2.35
Potassium, K - Dissolved						2.00		1.74	1.76	1.81	1.68
Selenium, Se - Total						<0.02		<0.02	<0.02	0.03	0.03
Selenium, Se - Dissolved						<0.02		<0.02	<0.02	<0.02	<0.02
Silver, Ag - Dissolved						<0.002		<0.002	<0.002	<0.002	<0.002
Sodium, Na - Total						99.90		96.04	92.22	104.43	105.41
Sodium, Na - Dissolved						89.00		95.59	92.22	98.2	93.24
Zinc, Zn - Dissolved						<0.004		0.009	0.096	<0.004	<0.004

nits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # MSP-82

SAMPLE DATE	5/25/2002	10/7/2002	6/3/2003	9/23/2003	6/4/2004
Analysis*					
Field Water Temperature C	6.8	4.6	5.1	5.9	5.0
pH (field)	7.66	8.01	7.70	7.98	7.87
Sp. Conductivity (field)	667	370	629	471	491
Flow gpm	2.383	1.303	5.384	1.259	3.601
Turbidity	0.00	0.00	16.95	1.47	0.00
Hardness, mg equivalent CaCO3/L					
Acidity					
Anions meq/L					
Balance %					
Cations meq/L					
Alkalinity, mg CaCO3/L (pH 4.5)					
Carbonate Alkalinity as CaCO3					
Bicarbonate Alkalinity as CaCO3					
Nitrogen, Ammonia					
Total Dissolved Solids					
Total Suspended Solids					
Nitrate + Nitrate as Nitrogen					
Chloride, Cl					
Sulfate, SO4					
Mercury, Hg - Dissolved µg/L					
Phosphorus, Total					
Metals *					
Aluminum, Al - Total					
Aluminum, Al - Dissolved					
Arsenic, As - Dissolved					
Boron, B - Dissolved					
Barium, Ba - Dissolved					
Cadmium, Cd - Dissolved					
Calcium, Ca - Total					
Calcium, Ca - Dissolved					
Chromium, Cr - Dissolved					
Copper, Cu - Dissolved					
Iron, Fe - Total					
Iron, Fe - Dissolved					
Lead, Pb - Dissolved					
Magnesium, Mg - Dissolved					
Manganese, Mn - Total					
Manganese, Mn - Dissolved					
Molybdenum, Mo - Dissolved					
Nickel, Ni - Dissolved					
Potassium, K - Total					
Potassium, K - Dissolved					
Selenium, Se - Total					
Selenium, Se - Dissolved					

Silver, Ag - Dissolved
Sodium, Na - Total
Sodium, Na - Dissolved
Zinc, Zn - Dissolved

ınits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # **M-SP87**

SAMPLE DATE	5/26/2002	9/29/2002	5/22/2003	10/7/2003	5/13/2004	6/30/2014	9/18/2014	11/5/2014	6/26/2015	9/29/2015	10/28/2015
Analysis*											
Field Water Temperature C	5.2	5.2	4.1	6.1	3.60	7.1	7.6	3.8	6.6	7.6	5.1
pH (field)	8.32	8.13	7.86	8.14	8.39	7.78	7.84	7.85	7.78	7.77	7.78
Sp. Conductivity (field)	681	627	699	770.00	1277	1282	1259	1301	1311	1224	1262
Flow gpm	2.193	2.313	3.079	2.51	2.907	1.14	0.92	1.15	1.08	0.8	0.58
Turbidity	0.25	0.05	16.17	5.020	0.59	NM	NM	NM	NM	NM	NM
Dissolved Oxygen	NM	NM	NM	6.6	NM	NM	NM	NM	NM	NM	NM
Hardness, mg equivalent CaCO3/L						470	470	210	460	471	474
Acidity						<5	<5	<5	<5	<5	5
Anions meq/L						14.47	15.44	4.74	14.59	15.12	14.5
Balance %						-0.77	-4.13	-1.59	-2.57	-2.12	-0.3
Cations meq/L						14.24	14.21	4.59	13.86	14.49	14.42
Alkalinity, mg CaCO3/L (pH 4.5)						362	361	225	370	361	364
Carbonate Alkalinity as CaCO3						<5	<5	26	<5	<5	<5
Bicarbonate Alkalinity as CaCO3						362	361	199	370	361	364
Nitrogen, Ammonia						<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Total Dissolved Solids						845	851	214	858	851	853
Total Suspended Solids							<5	68	<5	18	22
Nitrate						0.37	<0.05	0.46	<0.05	0.1	0.08
Nitrite						0.14	0.22	<0.05	<0.05	0.31	0.25
Nitrate + Nitrate as Nitrogen								0.46	2.83	1.79	0.33
Chloride, Cl						59	99	2	60	61	55
Sulfate, SO4						279	261	10	265	297	272
Ortho-Phosphate-P						<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mercury, Hg - Dissolved µg/L						<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phosphorus, Total						<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Metals *											
Aluminum, Al - Total						0.21	0.04	0.51	0.03	0.07	0.16
Aluminum, Al - Dissolved						<0.03	0.04	<0.03	<0.03	<0.03	<0.03
Arsenic, As - Dissolved						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron, B - Dissolved						0.12	0.12	<0.01	0.12	0.12	0.1
Barium, Ba - Dissolved						0.029	0.022	0.198	0.029	0.021	0.018
Cadmium, Cd - Dissolved						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium, Ca - Total						101.38	103.31	53.16	107.87	98.84	103.16
Calcium, Ca - Dissolved						101.00	100.27	45.60	92.73	98.84	103.16
Chromium, Cr - Dissolved						<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper, Cu - Dissolved						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, Fe - Total						0.25	<0.05	0.35	<0.05	0.14	0.27
Iron, Fe - Dissolved						<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead, Pb - Dissolved						<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium, Mg - Dissolved						53.00	53.33	23.28	55.40	54.52	52.53
Manganese, Mn - Total						0.013	0.004	0.022	0.010	0.011	0.016
Manganese, Mn - Dissolved						0.003	0.002	<0.002	0.003	<0.002	0.005
Molybdenum, Mo - Dissolved						<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nickel, Ni - Dissolved						<0.001	<0.001	<0.001	<0.001	0.001	0.002
Potassium, K - Total						4.34	3.93	0.71	4.00	4.55	4.2
Potassium, K - Dissolved						4.00	3.93	0.63	3.93	4.06	4.2
Selenium, Se - Total						<0.02	0.03	<0.02	<0.02	0.03	0.03
Selenium, Se - Dissolved						<0.02	0.02	<0.02	<0.02	<0.02	<0.02
Silver, Ag - Dissolved						0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Sodium, Na - Total						119.37	108.57	6.90	108.38	125.91	111.3
Sodium, Na - Dissolved						109.00	108.57	6.90	105.15	114.31	111.3
Zinc, Zn - Dissolved						<0.004	<0.004	<0.004	<0.004	<0.004	<0.004

nits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # M-SP100

SAMPLE DATE	9/27/2002	5/21/2003	10/8/2003	6/5/2004	6/27/2015	9/29/2015	11/7/2015
Analysis*							
Field Water Temperature C	6.8	7.9	6.7	9.4	6.3	7	6.8
pH (field)	7.25	7.35	7.38	7.47	7.51	7.47	7.46
Sp. Conductivity (field)	300	373	292	683	695	651	681
Flow gpm	0.774	0.840	0.794	1.076	0.802	0.77	0.754
Turbidity	0.20	38.78	0.83	0.51	NM	NM	NM
Hardness, mg equivalent CaCO3/L							
Acidity							
Anions meq/L							
Balance %							
Cations meq/L							
Alkalinity, mg CaCO3/L (pH 4.5)							
Carbonate Alkalinity as CaCO3							
Bicarbonate Alkalinity as CaCO3							
Nitrogen, Ammonia							
Total Dissolved Solids					389	407	384
Total Suspended Solids					12	46	87
Nitrate							
Nitrite							
Nitrate + Nitrite as Nitrogen							
Chloride, Cl							
Sulfate, SO4							
Ortho-Phosphate-P							
Mercury, Hg - Dissolved µg/L							
Phosphorus, Total							
Metals *							
Aluminum, Al - Total							
Aluminum, Al - Dissolved							
Arsenic, As - Dissolved							
Boron, B - Dissolved							
Barium, Ba - Dissolved							
Cadmium, Cd - Dissolved							
Calcium, Ca - Total							
Calcium, Ca - Dissolved							
Chromium, Cr - Dissolved							
Copper, Cu - Dissolved							
Iron, Fe - Total					<0.05	0.2	0.17
Iron, Fe - Dissolved							
Lead, Pb - Dissolved							
Magnesium, Mg - Dissolved							
Manganese, Mn - Total					0.004	0.016	0.012
Manganese, Mn - Dissolved							
Molybdenum, Mo - Dissolved							
Nickel, Ni - Dissolved							
Potassium, K - Total							
Potassium, K - Dissolved							
Selenium, Se - Total							
Selenium, Se - Dissolved							
Silver, Ag - Dissolved							
Sodium, Na - Total							
Sodium, Na - Dissolved							

Zinc, Zn - Dissolved

ınits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # M-SP103

SAMPLE DATE	5/21/2003	10/8/2003	6/5/2004	6/27/2015	9/29/2015	11/7/2015
Analysis*						
Field Water Temperature C	10.3	16.5	9.2	9.4	10.9	8.6
pH (field)	8.28	8.27	7.67	7.59	7.55	7.58
Sp. Conductivity (field)	377	416	706	703	669	675
Flow gpm	1.193	0.939	1.506	1.16	0.878	0.963
Turbidity	35.67	1.23	0.12	NM	NM	NM
Hardness, mg equivalent CaCO3/L						
Acidity						
Anions meq/L						
Balance %						
Cations meq/L						
Alkalinity, mg CaCO3/L (pH 4.5)						
Carbonate Alkalinity as CaCO3						
Bicarbonate Alkalinity as CaCO3						
Nitrogen, Ammonia						
Total Dissolved Solids				389	404	387
Total Suspended Solids				145	9	14
Nitrate						
Nitrite						
Nitrate + Nitrite as Nitrogen						
Chloride, Cl						
Sulfate, SO4						
Ortho-Phosphate-P						
Mercury, Hg - Dissolved µg/L						
Phosphorus, Total						
Metals *						
Aluminum, Al - Total						
Aluminum, Al - Dissolved						
Arsenic, As - Dissolved						
Boron, B - Dissolved						
Barium, Ba - Dissolved						
Cadmium, Cd - Dissolved						
Calcium, Ca - Total						
Calcium, Ca - Dissolved						
Chromium, Cr - Dissolved						
Copper, Cu - Dissolved						
Iron, Fe - Total				0.5	<0.05	<0.05
Iron, Fe - Dissolved						
Lead, Pb - Dissolved						
Magnesium, Mg - Dissolved						
Manganese, Mn - Total				0.035	<0.002	0.006
Manganese, Mn - Dissolved						
Molybdenum, Mo - Dissolved						
Nickel, Ni - Dissolved						
Potassium, K - Total						

Potassium, K - Dissolved
Selenium, Se - Total
Selenium, Se - Dissolved
Silver, Ag - Dissolved
Sodium, Na - Total
Sodium, Na - Dissolved
Zinc, Zn - Dissolved

units are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # M-SP104

SAMPLE DATE	5/21/2003	10/8/2003	6/5/2004	6/27/2015	9/29/2015	11/7/2015
Analysis*						
Field Water Temperature C	11.5		20.4	12.4	12.9	5.7
pH (field)	8.51		8.26	7.94	7.88	7.95
Dissolved Oxygen (field)	327		686	NM	NM	NM
Sp. Conductivity (field)	0.115		0.382	678	577	665
Flow gpm	12.51	NOF	2.75	0.279	0.279	0.355
Hardness, mg equivalent CaCO3/L						
Acidity						
Anions meq/L						
Balance %						
Cations meq/L						
Alkalinity, mg CaCO3/L (pH 4.5)						
Carbonate Alkalinity as CaCO3						
Bicarbonate Alkalinity as CaCO3						
Nitrogen, Ammonia						
Total Dissolved Solids				392	326	355
Total Suspended Solids				39	67	239
Nitrate						
Nitrite						
Nitrate + Nitrite as Nitrogen						
Chloride, Cl						
Sulfate, SO4						
Ortho-Phosphate-P						
Mercury, Hg - Dissolved µg/L						
Phosphorus, Total						
Metals *						
Aluminum, Al - Total						
Aluminum, Al - Dissolved						
Arsenic, As - Dissolved						
Boron, B - Dissolved						
Barium, Ba - Dissolved						
Cadmium, Cd - Dissolved						
Calcium, Ca - Total						
Calcium, Ca - Dissolved						
Chromium, Cr - Dissolved						
Copper, Cu - Dissolved						
Iron, Fe - Total				0.06	0.26	1.03
Iron, Fe - Dissolved						
Lead, Pb - Dissolved						
Magnesium, Mg - Dissolved						
Manganese, Mn - Total				0.011	0.023	0.274
Manganese, Mn - Dissolved						
Molybdenum, Mo - Dissolved						
Nickel, Ni - Dissolved						
Potassium, K - Total						

Potassium, K - Dissolved
Selenium, Se - Total
Selenium, Se - Dissolved
Silver, Ag - Dissolved
Sodium, Na - Total
Sodium, Na - Dissolved
Zinc, Zn - Dissolved

ınits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # M-SP105

SAMPLE DATE	5/21/2003	10/8/2003	6/5/2004	6/27/2015	9/29/2015	11/7/2015
Analysis*						
Field Water Temperature C	8.0	12.8	10.3	9.3	11.1	8.9
pH (field)	8.18	8.09	7.78	7.67	7.98	7.89
Sp. Conductivity (field)	363	381	696	700	646	665
Flow gpm	0.795	0.617	0.945	0.652	0.475	0.568
Turbidity	18.20	0.00	0.35	NM	NM	NM
Hardness, mg equivalent CaCO3/L						
Acidity						
Anions meq/L						
Balance %						
Cations meq/L						
Alkalinity, mg CaCO3/L (pH 4.5)						
Carbonate Alkalinity as CaCO3						
Bicarbonate Alkalinity as CaCO3						
Nitrogen, Ammonia						
Total Dissolved Solids				397	382	397
Total Suspended Solids				64	64	18
Nitrate						
Nitrite						
Nitrate + Nitrite as Nitrogen						
Chloride, Cl						
Sulfate, SO4						
Ortho-Phosphate-P						
Mercury, Hg - Dissolved µg/L						
Phosphorus, Total						
Metals *						
Aluminum, Al - Total						
Aluminum, Al - Dissolved						
Arsenic, As - Dissolved						
Boron, B - Dissolved						
Barium, Ba - Dissolved						
Cadmium, Cd - Dissolved						
Calcium, Ca - Total						
Calcium, Ca - Dissolved						
Chromium, Cr - Dissolved						
Copper, Cu - Dissolved						
Iron, Fe - Total				0.09	0.38	0.09
Iron, Fe - Dissolved				0.011	0.025	0.009
Lead, Pb - Dissolved						
Magnesium, Mg - Dissolved						
Manganese, Mn - Total						
Manganese, Mn - Dissolved						
Molybdenum, Mo - Dissolved						
Nickel, Ni - Dissolved						
Potassium, K - Total						

Potassium, K - Dissolved
Selenium, Se - Total
Selenium, Se - Dissolved
Silver, Ag - Dissolved
Sodium, Na - Total
Sodium, Na - Dissolved
Zinc, Zn - Dissolved

units are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # M-SP106

SAMPLE DATE	5/21/2003	10/8/2003	6/5/2004	6/27/2015	9/29/2015	11/7/2015
Analysis*						
Field Water Temperature C	4.7	7.3	7.6	6.1	7	5.5
pH (field)	7.84	7.68	7.70	7.67	7.65	7.61
Sp. Conductivity (field)	451	430	878	884	824	834
Flow gpm	0.685	1.095	0.476	0.345	0.339	0.325
Turbidity	9.42	6.80	116.00	NM	NM	NM
Hardness, mg equivalent CaCO3/L						
Acidity						
Anions meq/L						
Balance %						
Cations meq/L						
Alkalinity, mg CaCO3/L (pH 4.5)						
Carbonate Alkalinity as CaCO3						
Bicarbonate Alkalinity as CaCO3						
Nitrogen, Ammonia						
Total Dissolved Solids				539	519	543
Total Suspended Solids				32	52	229
Nitrate						
Nitrite						
Nitrate + Nitrite as Nitrogen						
Chloride, Cl						
Sulfate, SO4						
Ortho-Phosphate-P						
Mercury, Hg - Dissolved µg/L						
Phosphorus, Total						
Metals*						
Aluminum, Al - Total						
Aluminum, Al - Dissolved						
Arsenic, As - Dissolved						
Boron, B - Dissolved						
Barium, Ba - Dissolved						
Cadmium, Cd - Dissolved						
Calcium, Ca - Total						
Calcium, Ca - Dissolved						
Chromium, Cr - Dissolved						
Copper, Cu - Dissolved						
Iron, Fe - Total				0.32	0.51	1.92
Iron, Fe - Dissolved						
Lead, Pb - Dissolved						
Magnesium, Mg - Dissolved						
Manganese, Mn - Total				0.017	0.018	0.089
Manganese, Mn - Dissolved						
Molybdenum, Mo - Dissolved						
Nickel, Ni - Dissolved						
Potassium, K - Total						
Potassium, K - Dissolved						

Selenium, Se - Total
Selenium, Se - Dissolved
Silver, Ag - Dissolved
Sodium, Na - Total
Sodium, Na - Dissolved
Zinc, Zn - Dissolved

ınits are in mg/L unless otherwise noted

NM - Not Measured

SUMMARY OF WATER QUALITY ANALYSES

SUFCO SITE # M-SP206

SAMPLE DATE	9/18/2014
Analysis*	
Field Water Temperature C	
pH (field)	
Dissolved Oxygen (field)	
Sp. Conductivity (field)	
Flow gpm	
Hardness, mg equivalent CaCO3/L	137
Acidity	<5
Anions meq/L	10.13
Balance %	-0.57
Cations meq/L	10.01
Alkalinity, mg CaCO3/L (pH 4.5)	469
Carbonate Alkalinity as CaCO3	<5
Bicarbonate Alkalinity as CaCO3	469
Nitrogen, Ammonia	<0.1
Total Dissolved Solids	559
Total Suspended Solids	23
Nitrate	0.16
Nitrite	<0.05
Nitrate + Nitrite as Nitrogen	
Chloride, Cl	15
Sulfate, SO4	15
Ortho-Phosphate-P	<0.05
Mercury, Hg - Dissolved µg/L	<0.2
Phosphorus, Total	0.05
Metals*	
Aluminum, Al - Total	0.58
Aluminum, Al - Dissolved	<0.03
Arsenic, As - Dissolved	<0.01
Boron, B - Dissolved	0.05
Barium, Ba - Dissolved	0.193
Cadmium, Cd - Dissolved	<0.001
Calcium, Ca - Total	29.81
Calcium, Ca - Dissolved	28.45
Chromium, Cr - Dissolved	<0.001
Copper, Cu - Dissolved	<0.01
Iron, Fe - Total	0.39

Iron, Fe - Dissolved	<0.03
Lead, Pb - Dissolved	<0.01
Magnesium, Mg - Dissolved	62.02
Manganese, Mn - Total	0.016
Manganese, Mn - Dissolved	<0.002
Molybdenum, Mo - Dissolved	<0.005
Nickel, Ni - Dissolved	<0.001
Potassium, K - Total	1.25
Potassium, K - Dissolved	1.22
Selenium, Se - Total	<0.02
Selenium, Se - Dissolved	<0.02
Silver, Ag - Dissolved	<0.002
Sodium, Na - Total	167.69
Sodium, Na - Dissolved	166.53
Zinc, Zn - Dissolved	<0.004

ınits are in mg/L unless otherwise noted

NM - Not Measured

THE ENTIRE TEXT FOR EACH CHAPTER IS INCLUDED IN THIS SUBMITTAL FOR EASE OF REVIEW.

ONCE APPROVED ONLY PAGES WITH CHANGES WILL BE SUBMITTED.

CHAPTER 8

BONDING AND INSURANCE

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CHAPTER 8

BONDING AND INSURANCE

8.10 Bonding Definitions and Division Responsibilities

This chapter provides information regarding the bonding for coal mining and reclamation operations at the SUFCO 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.

8.20 Requirement to File a Bond

The area covered by the bond is outlined on Plate 5-2A,B,C,&D and in Volume 3 of this M&RP which includes all disturbed areas. The disturbed areas and specific acres to be reclaimed are listed in Section 1.1.6. 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 8.60.

8.30 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 5-9, Volume 6. However, if an adjustment in the bond coverage is necessary, the amount will be increased/decreased per the UDOGM's requirements.

8.40 General Terms and Conditions of the Bond

The performance bond is in the amount determined by the UDOGM as described in Section 8.30 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, SUFCO Mine. Duration of the bond is described in Section 8.20.

8.50 Bonding Requirements for Underground Coal Mining and Reclamation Activities and Associated Coal-Related Surface Facilities and Structures

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 30 days prior to expiration of coverage.

8.60 Forms of Bonds

The surety bond for the applicant has been executed per the documentation within the reclamation agreement. ~~by "United Pacific Insurance Company" a corporate surety licensed to do business in Utah.~~ The surety bond will be noncancellable during its term except with the prior consent of the Division of Oil, Gas and Mining (UDOGM).

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

8.70 Replacement of Bonds

SUFCO 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.

8.80 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.

8.90 Terms and Conditions for Liability Insurance

Certificates of Insurance issued to Canyon Fuel Company LLC, SUFCO Mine are submitted to the Division upon renewal ~~as Appendix 8-1.~~ 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 SUFCO 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.

THE ENTIRE TEXT FOR EACH CHAPTER IS INCLUDED IN THIS SUBMITTAL FOR EASE OF REVIEW.

ONCE APPROVED ONLY PAGES WITH CHANGES WILL BE SUBMITTED.

CHAPTER 9

ALLUVIAL VALLEY FLOOR

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CHAPTER 9

ALLUVIAL VALLEY FLOORS

3.20 Alluvial Valley Floors

All coal mining operations must provide to the UDOGM a determination that the regulations of R645-302-320 do not apply.

3.2.1 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.

3.2.1.2 Studies Performed During Investigation

The studies for AVF determination may include:

- o 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;

- o 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;

- o 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.

Greens Hollow Lease

Much of the information presented for the permitting of the Greens Hollow Lease (GHL) was prepared with a conceptual mine plan assuming full extraction mining, associated subsidence and represents maximum impacts in the Bureau of Land Management's Environmental Impact Statement (FSEIS) . The information in the text represents the permittees accepted obligations and commitments, the information provided in appendices from the (FSEIS) unless reference specifically is provided as background or baseline for the obligations and commitments within the text.

3.2.1.3 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 9-1, 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 following drainages: Mine Permit Area, Mine Plan Area and Affected Area (see Plate 9-1)

   A. North Fork Quitchupah Creek. This 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.

   B. East Spring Canyon. Characteristics of unconsolidated alluvium are the same as in North Fork Quitchupah Canyon.

   C. Duncan Draw. This drainage within the permit boundary is narrow and steep with a few small (less than 1 acre) patches of alluvium present. Bedrock is exposed in much of the drainage.

   D. Unnamed tributary to Duncan Draw. (T21S, R5E, Section 31E1½). This drainage is steep, but contains narrow patches of unconsolidated alluvium. This drainage has not been investigated in detail, but areas underlain by unconsolidated alluvium are estimated to aggregate a few acres in size.

   E. Unnamed tributaries to East Spring Canyon. These small drainages are east of Section 1, R4E, T22S, and are tributaries to East Spring Canyon (Plate 9-1). These drainages are narrow and steep, but have a few scattered patches of unconsolidated alluvium. No detailed investigation of these drainages has been made, but areas underlain by unconsolidated alluvium are estimated to aggregate only a few acres in size.

   F. North Fork Quitchupah Creek downstream from mine permit area. While the canyon is steep and narrow, there are unconsolidated alluvial deposits toward the lower end. Similarly, in the adjacent area at the upper end of North Fork

Quitchupah Canyon and its South Fork tributary are small narrow areas underlain by consolidated alluvium. None of these deposits have been mapped in detail.

G. Duncan Draw and Mud Springs Hollow. The segments of Duncan Draw and Mud Spring Hollow in the adjacent area contain some small areas underlain by unconsolidated alluvium. Both these canyons are narrow and steep, and probably there are no areas in the canyon where unconsolidated alluvium underlies more than 10 acres.

H. Convulsion Canyon and Quitchupah Creek. These drainages contain narrow deposits of unconsolidated alluvium. The canyon bottoms are narrow, but alluvium may be as much as 75 feet thick. Streams are deeply incised into the alluvium creating steep banks with a narrow stream channel in the bottoms. These unconsolidated deposits have not been mapped in detail.

I. Muddy Creek Canyon. The portion of the Muddy Creek Canyon that is within and adjacent to the Pines Tract is relatively narrow with unconsolidated alluvium. Alluvium in the bottom of the narrow canyon varies in depth from 0 to more than 50 feet thick. Side drainages are deeply incised into the alluvium creating steep banks with narrow stream channel bottoms. These unconsolidated deposits have not been mapped in detail. A few miles downstream of the Pines Tract the alluvial deposits have been irrigated and cultivated in the past.

J. Box Canyon. The drainages associated with Box Canyon have a relatively steep gradient and contain limited very narrow deposits of unconsolidated alluvium. The canyon bottoms are narrow and alluvium is typically less than 15 feet thick. Much of the floor of the channel rests directly on bedrock. These unconsolidated deposits have not been mapped in detail.

K. Canyons of Greens Hollow Tract. The drainages have a relatively steep gradient and contain limited very narrow deposits of unconsolidated alluvium. The canyon bottoms are narrow and alluvium is shallow. Much of the floor of the channel rests directly on bedrock. These unconsolidated deposits have not been mapped in detail. Refer to the Geologic Fence Diagram in Appendix 6-4.

2. There is no flood irrigation in the mine plan area or the adjacent area and no evidence of historical use of flood irrigation.

3. Flood irrigation may be possible on a few small patches of alluvium in drainages in the mine permit area. Mud Springs Hollow, Duncan Draw, and the uppermost segment of East Spring Canyon all have small areas underlain by alluvium that could be flood irrigated. 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.

4. In the adjacent area, flood irrigation may be possible in a few locations. This includes:

   A. North Fork Quitchupah Creek and Quitchupah Creek. In the lower segments of these drainages are narrow alluvial deposits. Due to their small size, steepness, deeply incised streams and rough terrain, flood irrigation is not feasible. Regionally, relatively flat, wide drainage bottoms are flood irrigated. Alluvium in drainages with characteristics similar to Quitchupah Creek and its North Fork, however, are not flood irrigated.

   B. Duncan Draw, Mud Spring Hollow and small tributaries of the upper segment of North Fork Quitchupah Creek and its South Fork. These drainages may have small areas capable of flood irrigation. Due to small size, steepness, 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.

   C. Muddy Creek Canyon. This drainage may have small areas capable of flood irrigation. These areas are located at least 1 mile downstream of the Pines Tract. Due to the limited areal extent, limited access, steepness, land ownership, short growing season, and difficulty in maintaining a diversion, these areas would not be practical for flood irrigation.

5. Subirrigated lands are present in both the mine permit and adjacent areas where agriculturally useful vegetation is dependent on moisture supplied by groundwater or frequent flood flows. In the mine permit area, small areas (less than 2 acres) are present along Duncan Draw and the uppermost end of East Spring Canyon. Limited subirrigated lands are also present in Box Canyon and its tributaries. There are small, narrow areas where riparian vegetation is present along stream banks that are subirrigated.

In the adjacent area, small areas of subirrigated rangeland are present. The upper segmentof Duncan Draw, Mud Spring Hollow, Convulsion Canyon, and North Fork Quitchupah Creek and its South Fork, and portions of Muddy Creek contain small subirrigated areas. Narrow strips of riparian vegetation present along stream banks are subirrigated.

General Area

A potential AVF exists along portions of Quitchupah Creek from the adjacent area boundary downstream to the general area boundary. This area has not been investigated in detail; however, flood irrigation is practiced on approximately 110 acres and an additional 25 acres may have been irrigated in the past (Plate 9-1). Quitchupah Creek in this segment is deeply incised into the alluvium creating steep banks with a narrow stream channel. Thickness of the alluvium is unknown, but probably is greater than 50 feet.

3.2.2 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 these areas. A possible AVF exists in the general area along Quitchupah Creek downstream of the adjacent area boundary. Approximately 110 acres are being irrigated at this location (Plate 9-1). There appear to be no other potential alluvial valley floors in the general area.

All of the surface on the Quitchupah Lease is owned by the United States. The surface management agencies (USFS and BLM) have determined that no alluvial valley floors exist on the lease. Their finding is documented on page 6 in the Environmental Assessment for the Quitchupah Lease Tract included as Appendix 9-1.

All of the surface on the Pines Tract Lease is owned by the United States. Based on the above discussions, the Natural Resources Conservation Service Determination on the Pines Tract (located in Appendix 2-1), and the information provided in Chapters 2, 3, 6, and 7, alluvial valley floors are not present within the Pines Tract.

All of the surface on the SITLA Muddy Tract Lease is owned by the United States. Based on the above discussions, and the information provided in Chapters 2, 3, 6, and 7, alluvial valley floors are not present within the SITLA Muddy Tract.

The Greens Hollow Tract Lease is owned by the United States. Based on the above discussions, and the information provided in Chapters 2, 3, 6, and 7, alluvial valley floors are not present within the Tract.

EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- MC 100000 MINE COORDINATES
- 2020000 SPC STATE PLANE COORDINATES

SOIL TYPES

7	SHUPERT–WINETTI FAMILIES
20	STRYCH–PATHEAD–WIGGLER FAMILIES
20A	ANDOK–STRYCH–WIGGLER FAMILIES
20X	ANDOK–WELRING FAMILIES
24	RABBITEX–REPP FAMILIES
24A	WHETROCK–DETRA FAMILIES
26	MARA–RABBITEX FAMILIES
35	DETRA FAMILY
57	FALCON FAMILY
107	BUNDO–SCOUT–UINTA FAMILIES
107A	CIRCLEVILLE–SCOUT–PANGUITCH FAMILIES
110	CASTINO–ELWOOD FAMILIES
600	FAIM–CLAYBURN–CASTINO FAMILIES
640	KILDOR FAMILY
715A	CROYDON–MORTENSON FAMILIES
570	LUCKY STAR–PRITCHETT FAMILIES

SOURCE:
COAL TRACT EVALUATIONS ON THE MANTI–LA SAL NATIONAL FOREST
MUDDY TRACT SOILS MAP
MARCH 2004
CIRRUS ECOLOGICAL SOLUTIONS, LC
965 SOUTH 100 WEST, SUITE 200
LOGAN, UTAH 84321
NATIONAL FORESTS SOIL SURVEY DATA
UTM NAD 83 ZONE 12N METERS 2013–2014

PROFESSIONAL ENGINEER
8/9/16
No. 9073281
JACOB D. SMITH
STATE OF UTAH

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2000 0 2000

REVISIONS

NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	05/08/2007	M.L.D.	B.D.H.	
2	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
3	04/26/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

_1Stndrd-SUFENP1.ctb

PEN TBL:

SHT SET: ####

PROJECT NUMBER: ####

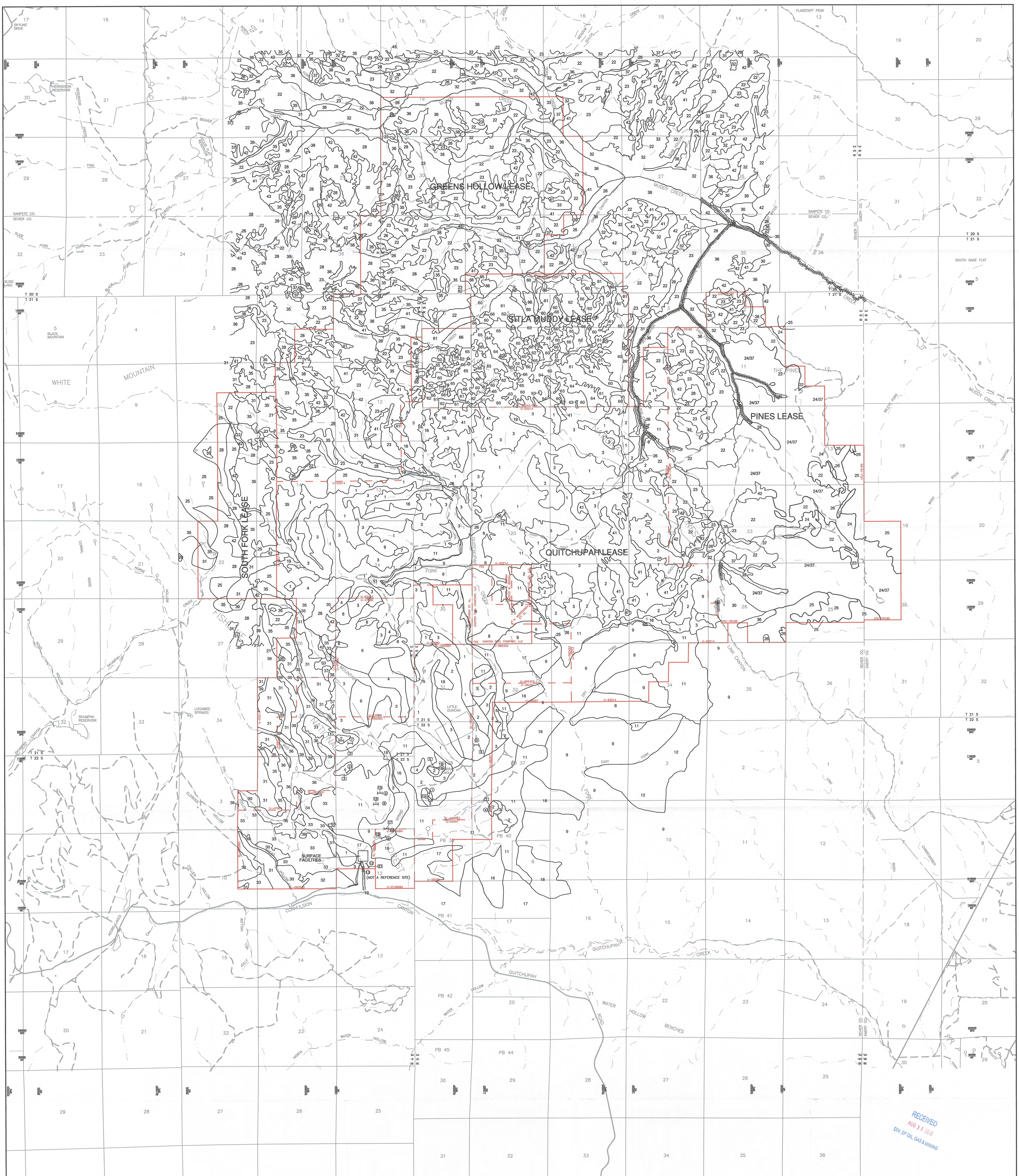
Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

SOIL TYPES
SITLA MUDDY & GREENS HOLLOW TRACT

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 2000'	8/8/2016	B.D.H.		M.L.D.	PLATE 2–3

FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4-26-16\PLATE 2-3.dwg

Tmitchell: 8/8/2016 1:56 PM



QUITCHUPAH LEASE PLANT COMMUNITIES

SOURCE:
SOUTHERN UTAH FUEL COMPANY
CONVULSION CANYON AND QUITCHUPAH TRACTS
VEGETATION MAP
EPS, INC. 129 NORTH 1000 EAST
OREM, UTAH 84057
1 OCTOBER 1991

1. SAGEBRUSH–GRASS
2. GRASS–BLACK SAGEBRUSH
3. MOUNTAIN BRUSH (OAK–SERVICEBERRY MOUNTAIN MAHOGANY, ETC.)
4. ASPEN
5. ASPEN–OAK
6. ASPEN–DOUGLAS FIR–LIMBER PINE
7. MOUNTAIN MAHOGANY–OAK–PONDEROSA PINE
8. DOUGLAS FIR–SPRUCE–LIMBER PINE
9. PINYON–JUNIPER–MOUNTAIN MAHOGANY
10. LIMBER PINE
11. PONDEROSA PINE–MOUNTAIN MAHOGANY–MANZANITA
12. PINYON–JUNIPER–DOUGLAS FIR
13. WIREGRASS–FOXTAIL–HAPLOPAPPUS
14. DOUGLAS FIR–SPRUCE–LIMBER PINE–ASPEN
15. LIMBER PINE–MOUNTAIN MAHOGANY–SERVICEBERRY
16. MOUNTAIN MAHOGANY
17. PINYON–JUNIPER
18. DOUGLAS FIR & OTHER
19. RIPARIAN
20. PONDEROSA PINE–DOUGLAS FIR–ASPEN–SERVICEBERRY

LEASE PLAN COMMUNITIES

SOURCE:
FISHLAKE NATIONAL FOREST VEGETATION GROUPS
MANTI–LA SAL NATIONAL FOREST
FES FIGURE 3–10 VEGETATION TYPES
JANUARY 1999
MANTI–LA SAL NATIONAL FOREST
FEIS, FIGURE 4–6 DECEMBER 2011

21. GRASSLAND PERENNIAL FORBS
22. SAGEBRUSH
23. MOUNTAIN BRUSH – SHRUBS
24. CONIFER TIMBER
25. MIXED CONIFER
26. BARREN GROUND
27. ASPEN – DECIDOUS FOREST
28. ASPEN – MIXED CONIFER
29. COTTONWOOD – BRUSH
30. PINYON – JUNIPER
31. GAMBEL OAK – OAK BRUSH
32. MOUNTAIN MAHOGANY
33. JUNIPER – MAHOGANY – WOODLAND
34. PONDEROSA PINE
35. ASPEN
36. FIR FOREST
37. PINE FOREST
38. HIGH MOUNTAIN BRUSH
39. RIPARIAN – WETLANDS – MEADOW
40. MANZANITA
41. PERENNIAL FORB LAND (ELEVATION MID–LOW)
42. PERENNIAL GRASSLAND (LOW ELEVATION)
43. PERENNIAL GRASSLAND (MID ELEVATION)
44. INTERMITTENT WET – DRY MEADOW
45. WILLOW – DOMINATED RIPARIAN

SITLA MUDDY LEASE PLANT COMMUNITIES

SOURCE:
MT NEBO SCIENTIFIC, INC.
RESEARCH & CONSULTING
330 EAST 400 SOUTH, SUITE 6
SPRINGVILLE, UTAH 84663
PATRICK D. COLLINS Ph.D. JANUARY 30, 2008

60. SAGEBRUSH/GRASS
61. MOUNTAIN BRUSH
62. MOUNTAIN HERBLANDS
63. OAK BRUSH
64. PINYON–JUNIPER
65. ASPEN
66. CONIFER

PROFESSIONAL ENGINEER
8/9/16
No. 9073281
JACOB D. SMITH
STATE OF UTAH

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EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- 100000 MC — MINE COORDINATES
- 2020000 SPC — STATE PLANE COORDINATES
- VEGETATION SAMPLE SITE
- 22 — SOIL SAMPLE SITE
- 12 — VEGETATION SAMPLE NUMBER
- RIPARIAN AREAS

2000 0 2000

RECEIVED
AUG 11 2016
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REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
4	01/20/2005	M.L.D.	B.D.H.	
5	09/12/2005	M.L.D.	B.D.H.	
6	05/08/2007	M.L.D.	K.B.B.	
7	02/14/2008	M.L.D.	K.B.B.	
8	06/11/2010	M.L.D.	K.B.B.	
9	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
10	07/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

PLANT COMMUNITIES AND SAMPLING AREA

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 2,000'	7/27/2016	B.D.H.		M.L.D.	PLATE 3–1

FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4–26–16\PLATE 3–1.dwg

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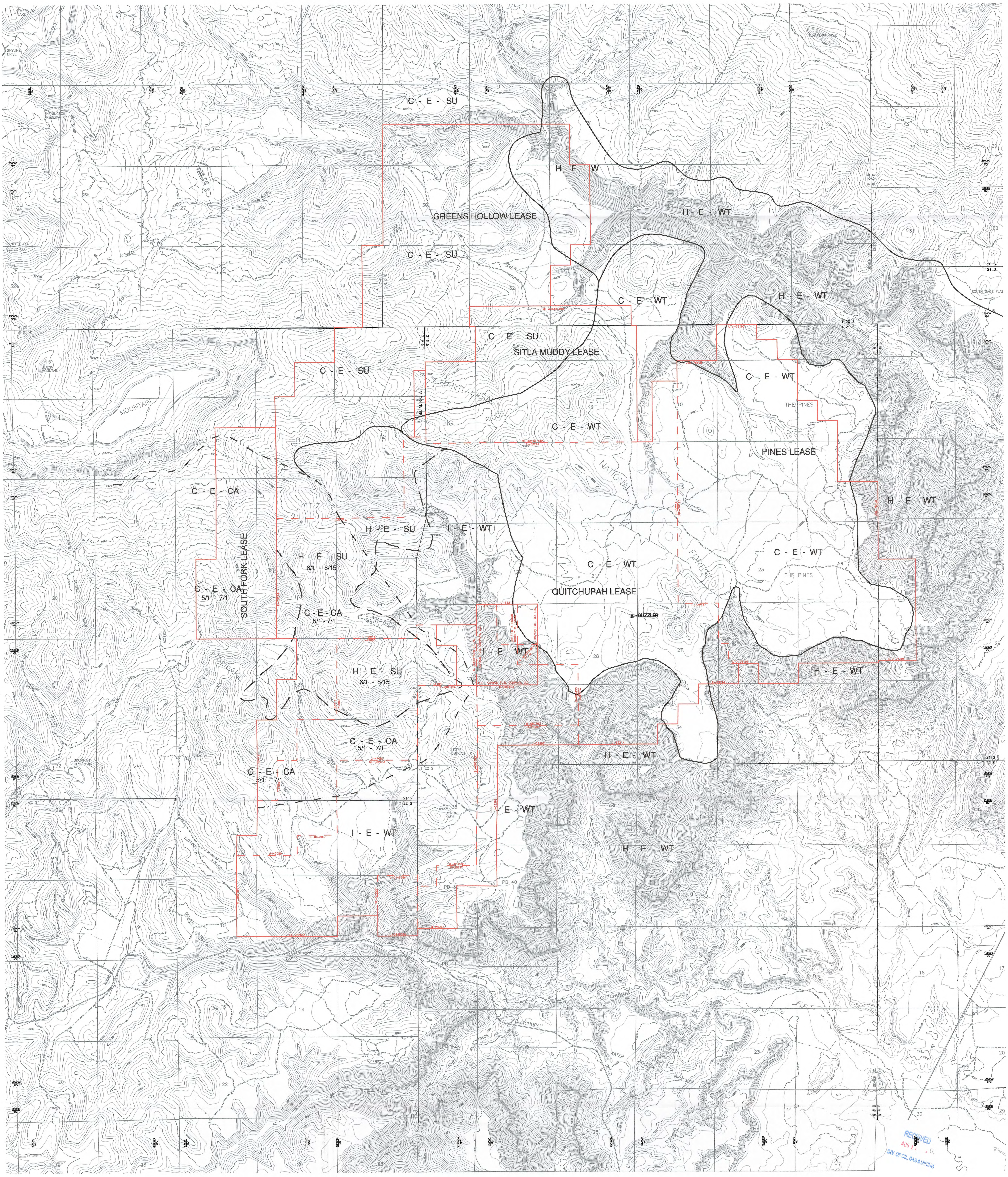

EXPLANATION

(red solid line)	SUFCO EXTERIOR LEASE BOUNDARY
(red dashed line)	SUFCO INTERIOR LEASE BOUNDARY
100000 / MC	MINE COORDINATES
2020000 / SPC	STATE PLANE COORDINATES
C - E - CA	CRITICAL ELK CALVING AREA
C - E - SU	CRITICAL ELK SUMMER RANGE
C - E - WT	CRITICAL ELK WINTER RANGE
H - E - SU	HIGH PRIORITY ELK SUMMER RANGE
H - E - WT	HIGH PRIORITY ELK WINTER RANGE
I - E - WT	LIMITED USE ELK WINTER RANGE
	CRITICAL ELK CALVING AREA BOUNDARY (WEST OF BOUNDARY LINE)
	HIGH PRIORITY SUMMER RANGE BOUNDARY
	HIGH PRIORITY WINTER RANGE BOUNDARY
5/1 - 7/1	PERIOD OF HEAVIEST RANGE USE
X	GUZZLER

SOURCES:

1. QUITCHUPAH TRACT
   DIVISION OF WILDLIFE RESOURCES
   CEDAR CITY, UTAH
   PAMELA HILL, NOV. 12, 1991
2. PINES TRACT
   DIVISION OF WILDLIFE RESOURCES
   PRICE, UTAH
   PINES TRACT CRITICAL/HIGH VALUE ELK RANGES MAP
   CHRIS COLT, FEB. 27, 1999
3. SITLA MUDDY TRACT
   COAL TRACT EVALUATIONS ON THE MANTI–LA SAL NATIONAL FOREST
   MUDDY TRACT ELK RANGE
   MARCH 2004
   CIRRUS ECOLOGICAL SOLUTIONS, LC
   965 SOUTH 100 WEST, SUITE 200
   LOGAN, UTAH 84321

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REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
2	03/01/2000	M.L.D.	B.D.H.	
3	01/20/2005	M.L.D.	B.D.H.	
4	09/12/2005	M.L.D.	B.D.H.	
5	05/08/2007	M.L.D.	K.B.B.	
6	06/11/2010	M.L.D.	K.B.B.	
7	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
8	07/25/2016	V.M.	J.G.C.	ADD GREENS HOLLOW &SOUTH FORK LEASE BOUNDARIES

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

ELK RANGE

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 2,000'	8/4/2016	A.D.D.		M.L.D.	PLATE 3–2

FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4-26-16\PLATE 3-2.dwg

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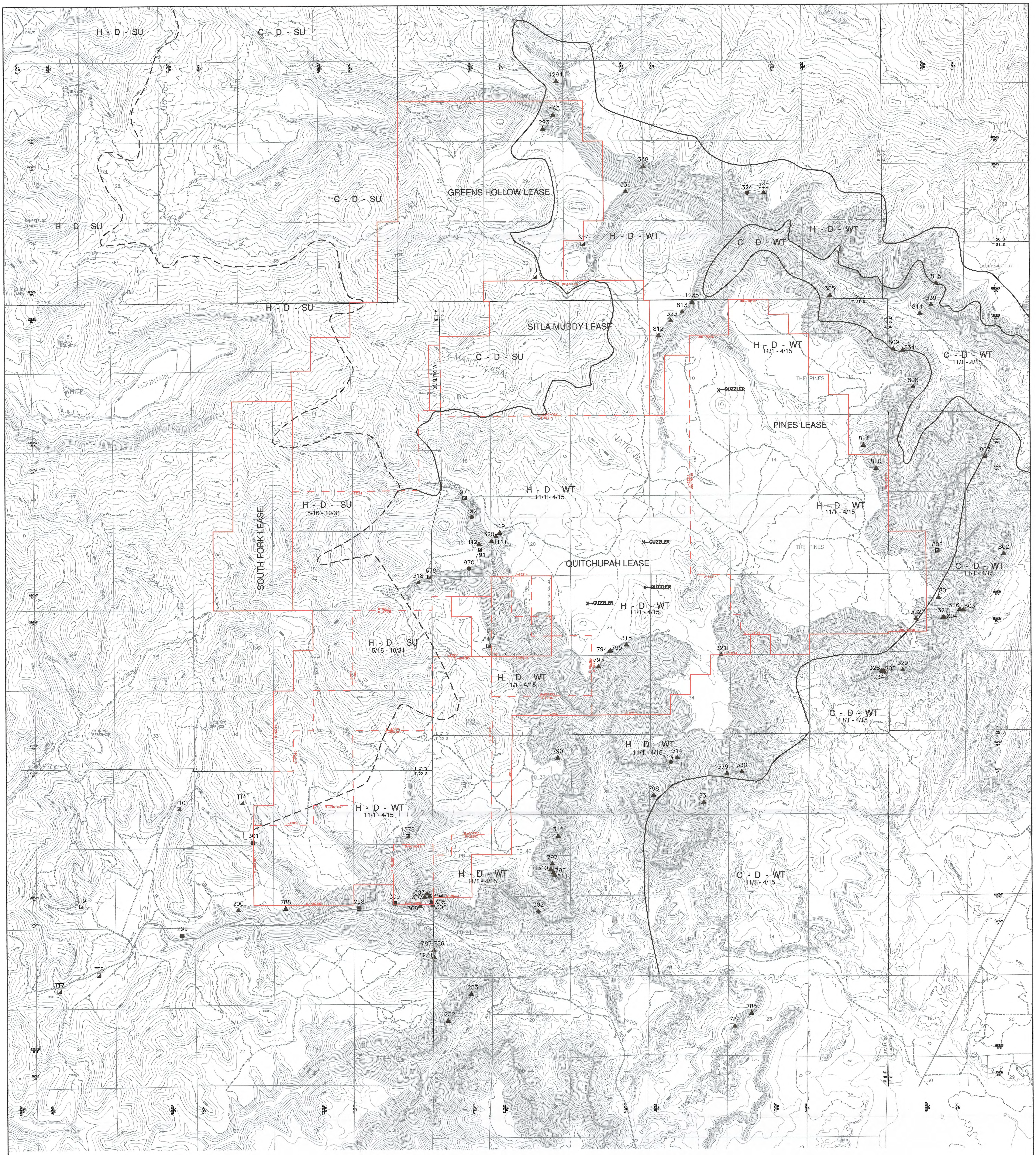

EXPLANATION

SUFCO EXTERIOR LEASE BOUNDARY
SUFCO INTERIOR LEASE BOUNDARY
100000 MC — MINE COORDINATES
2020000 SPC — STATE PLANE COORDINATES
C - D - SU — CRITICAL DEER SUMMER RANGE
C - D - WT — CRITICAL DEER WINTER RANGE
H - D - SU — HIGH PRIORITY DEER SUMMER RANGE
H - D - WT — HIGH PRIORITY DEER WINTER RANGE
11/1 – 4/15 — PERIOD OF HEAVIEST RANGE USE
HIGH PRIORITY SUMMER RANGE BOUNDARY
CRITICAL WINTER RANGE BOUNDARY
X — GUZZLER
BUTEO
FALCON
PRAIRIE FALCON
PEREGRINE FALCON
RAVEN
REDTAIL HAWK
GOLDEN EAGLE

SOURCE:
RAPTOR NESTS:

DIVISION OF WILDLIFE RESOURCES
475 WEST PRICE RIVER DRIVE
PRICE, UTAH
RAPTOR SURVEY 2004
ANTHONY WRIGHT, JUNE 16, 2004
TETRA TECH
2012–2014

DEER RANGE:

1. QUITCHUPAH TRACT
   DIVISION OF WILDLIFE RESOURCES
   CEDAR CITY, UTAH
   PAMELA HILL, NOV. 12, 1991
2. PINES TRACT
   DIVISION OF WILDLIFE RESOURCES
   PRICE, UTAH
   PINES TRACT CRITICAL/HIGH VALUE DEER RANGES MAP
   CHRIS COLT, FEB. 27, 1999
3. SITLA MUDDY TRACT
   COAL TRACT EVALUATIONS ON THE MANTI–LA SAL NATIONAL FOREST
   MUDDY TRACT DEER RANGE MAP
   MARCH 2004
   CIRRUS ECOLOGICAL SOLUTIONS, LC
   965 SOUTH 100 WEST, SUITE 200
   LOGAN, UTAH 84321
4. DEER HERD UNIT MANAGEMENT PLAN
   DEER UNIT 16C. OCT. 2015

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REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
4	05/24/2002	M.L.D.	B.D.H.	
5	01/20/2005	M.L.D.	B.D.H.	
6	09/12/2005	M.L.D.	B.D.H.	
7	05/08/2007	M.L.D.	K.B.B.	
8	06/11/2010	M.L.D.	K.B.B.	
9	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
10	04/27/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

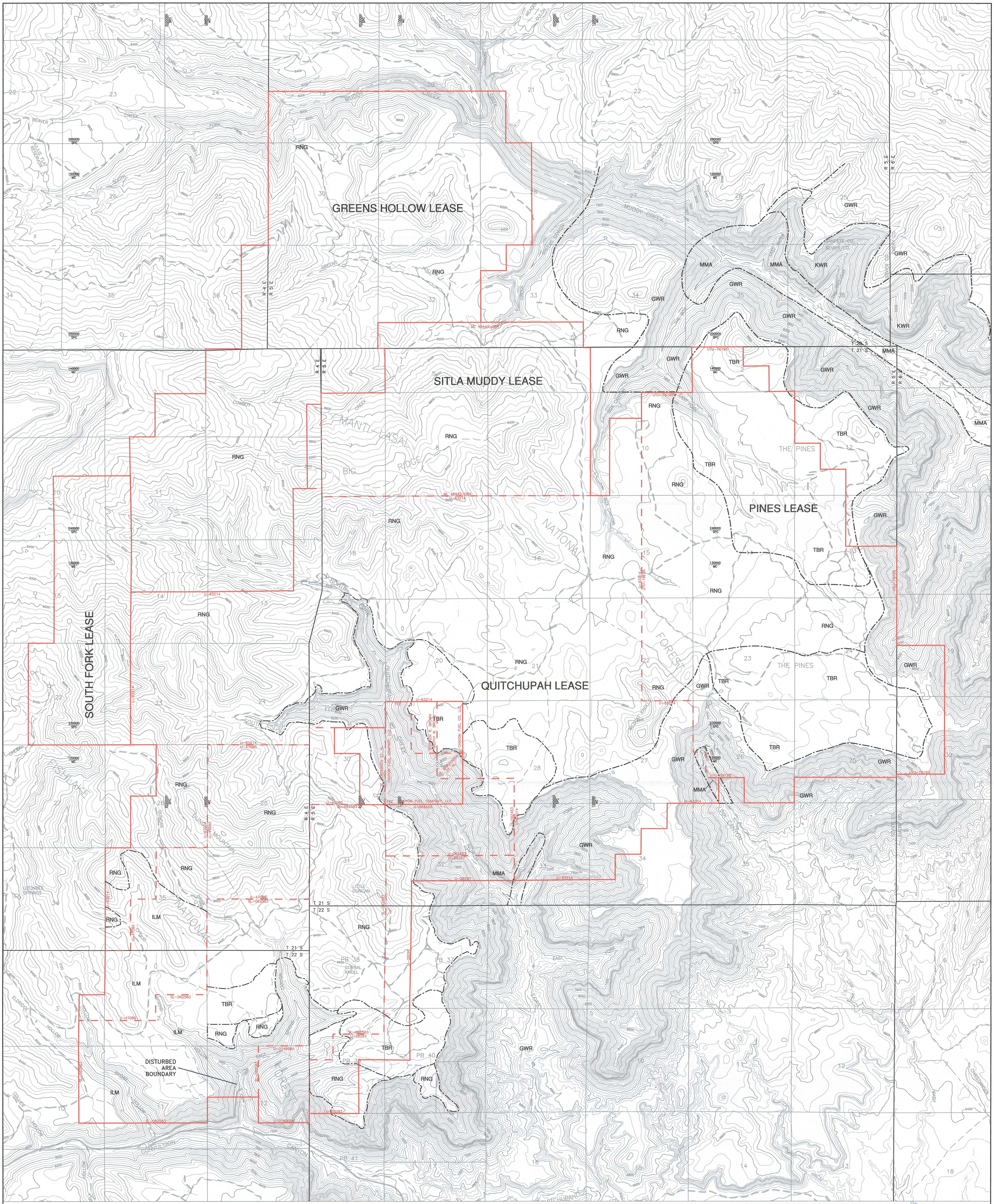
PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

DEER RANGE AND RAPTOR NESTS

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 2,000'	5/24/2016	B.D.H.		M.L.D.	PLATE 3–3

FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4-26-16\PLATE 3-3.dwg



EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- 100000 / MC — MINE COORDINATES
- 2020000 / SPC — STATE PLANE COORDINATES

SITLA MUDDY TRACT

FOREST MANAGEMENT UNITS

	FOREST MANAGEMENT UNIT BOUNDARY
GWR	GENERAL BIG GAME WINTER RANGE
TBR	LIMITED TIMBERING, INCLUDES GRAZING
RNG	RANGELAND/GRAZING
MMA	LEASABLE MINERAL DEVELOPMENT
ILM	INTERMEDIATE LOGGING MANAGEMENT
MMA	LEASABLE MINERAL DEVELOPMENT

SOURCE:
SOUTHERN UTAH FUEL COMPANY
CONVULSION CANYON AND QUITCHUPAH TRACTS
FOREST MANAGEMENT UNITS MAP
EPS, INC. 129 NORTH 1000 EAST
OREM, UTAH 84057
1 OCTOBER 1991

PROFESSIONAL ENGINEER
8/9/16
No. 9073281
JACOB D. SMITH
STATE OF UTAH

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1000 0 1000

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1 1 2016
DIV. OF OIL, GAS & MINING

NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	02/10/1999	M.L.D.	B.D.H.	
2	03/01/2000	M.L.D.	B.D.H.	
3	01/20/2005	M.L.D.	B.D.H.	
4	09/12/2005	M.L.D.	B.D.H.	
5	05/08/2007	M.L.D.	K.B.B.	
6	06/11/2010	M.L.D.	K.B.B.	
7	07/14/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

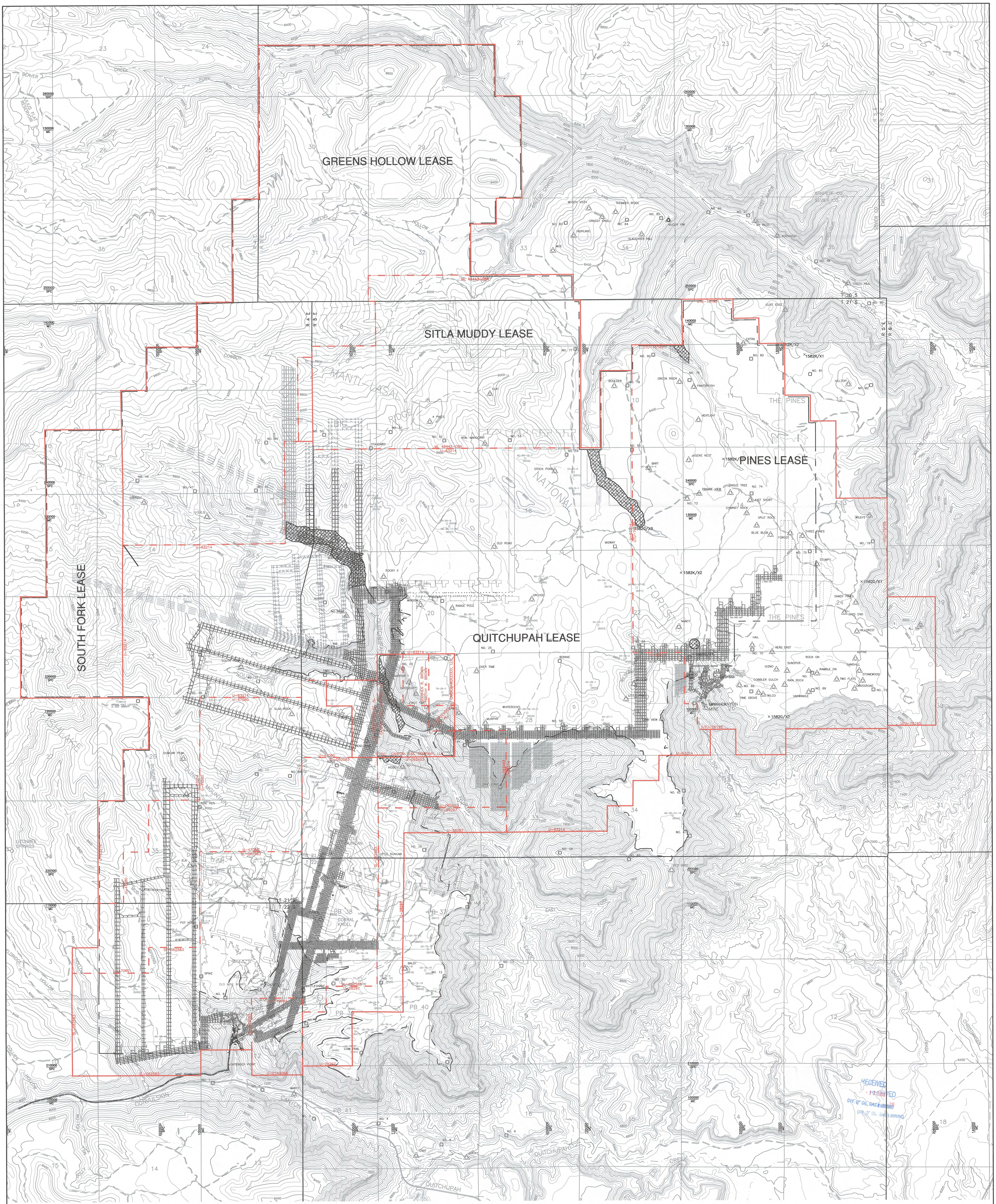
REVISIONS

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

LAND USES – SITLA MUDDY AND GREENS HOLLOW TRACT

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: ####
PROJECT NUMBER: ####
SCALE: 1" = 1,500'
DATE: 7/19/2016
DRAWN BY: A.D.D.
ENGINEER:
CHECKED BY: J.D.B.
SHEET NO. PLATE 4-1B
FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4-26-16\PLATE 4-1.dwg

Tmitchell: 7/19/2016 2:52 PM



EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- 100000 MC — MINE COORDINATES
- 2020000 SPC — STATE PLANE COORDINATES
- CONTROL POINT
- AERIAL TARGET
- LIMIT OF POTENTIAL SUBSIDENCE
- UNDERGROUND PERENNIAL STREAM AND PROTECTED CULTURAL SITE BUFFER CORRIDOR

PROFESSIONAL ENGINEER
8/9/16
No. 9073281
JACOB D. SMITH
STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

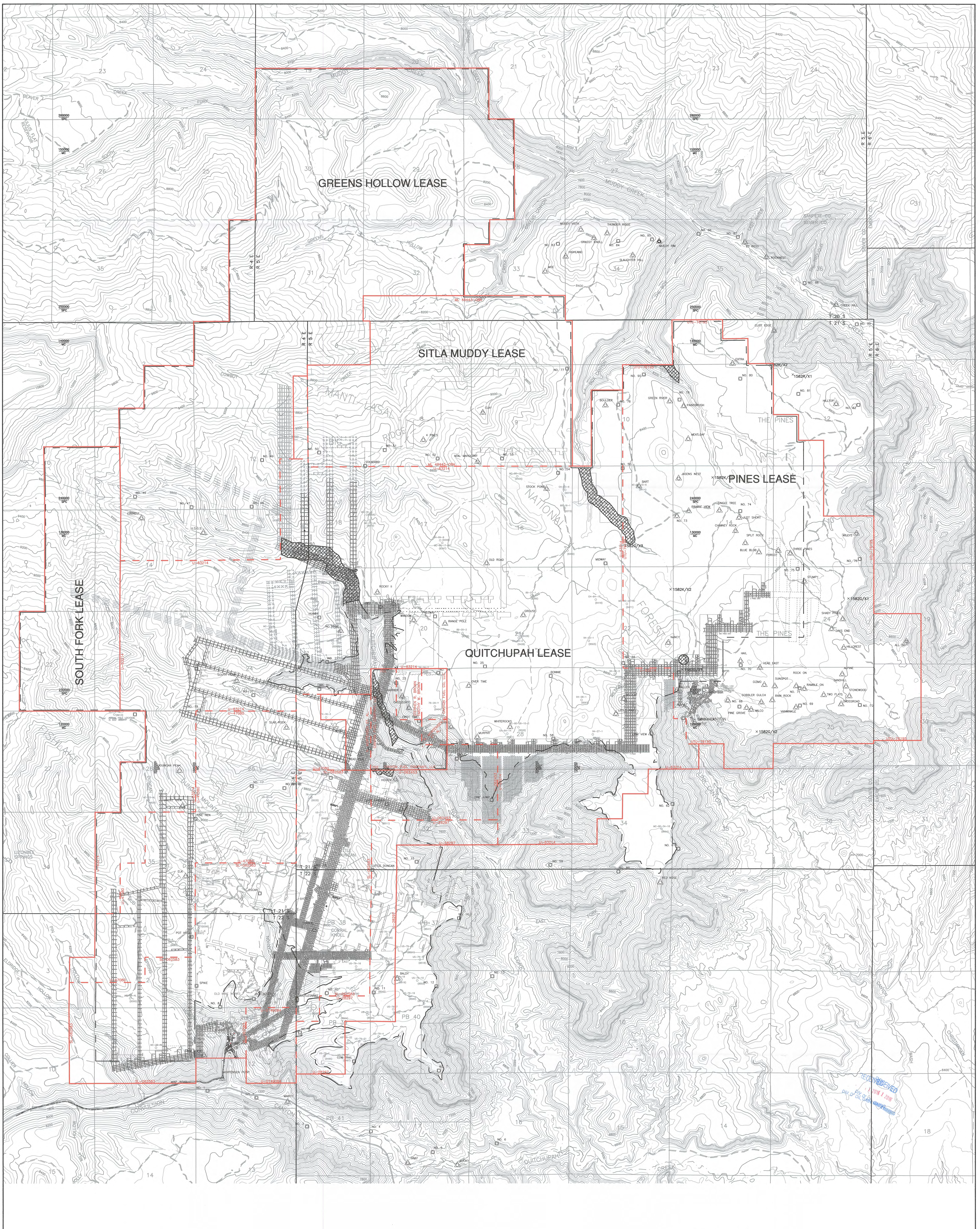
1000 0 1000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
6	07/28/2003	MLD	BDH	
7	01/20/2005	MLD	BDH	
8	08/16/2009	MLD	BDH	
9	09/11/2010	MLD	KBB	
10	07/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

POTENTIAL SUBSIDENCE LIMITS
QUITCHUPAH TRACT

SCALE:	DATE:	DRAWN BY:	ENGINEER:	SHEET NO.
1" = 1500'	01/14/97	JMB		PLATE 5–10A
CHECKED BY: WKS	FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE5–10.dwg			



EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- 100000 / MC — MINE COORDINATES
- 2020000 / SPC — STATE PLANE COORDINATES
- CONTROL POINT
- AERIAL TARGET
- LIMIT OF POTENTIAL SUBSIDENCE
- UNDERGROUND PERENNIAL STREAM AND PROTECTED CULTURAL SITE BUFFER CORRIDOR

PROFESSIONAL ENGINEER
No. 9073281
JACOB D. SMITH
STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

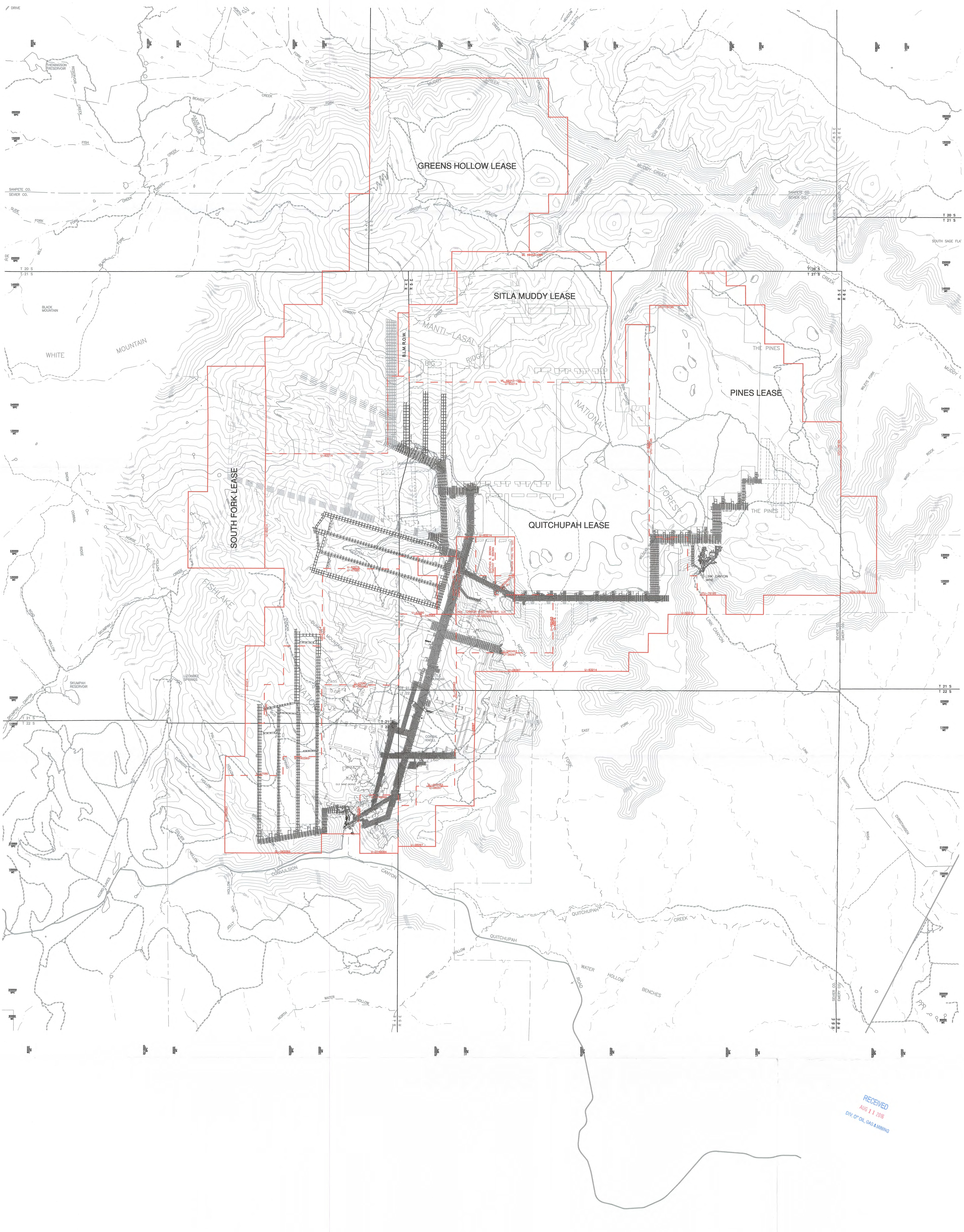
1000 0 1000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	08/13/09	MLD	KBB	
2	07/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE
				BOUNDARIES

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

POTENTIAL SUBSIDENCE LIMITS
SITLA MUDDY & GREENS HOLLOW TRACT

SCALE:	DATE:	DRAWN BY:	ENGINEER:	SHEET NO.
1" = 1000'	08/13/09	JMB		PLATE 5-10C
CHECKED BY:	FILE NAME:			
WKS	H:\DRAWINGS\MRP\PLATES\PLATE 5-10.dwg			



EXPLANATION

SUFCO EXTERIOR LEASE BOUNDARY
SUFCO INTERIOR LEASE BOUNDARY
MINE COORDINATES
STATE PLANE COORDINATES

PROFESSIONAL ENGINEER
8/9/16
No. 9073281
JACOB D. SMITH
STATE OF UTAH

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REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	01/20/2005	M.L.D.	B.D.H.	
2	05/08/2007	M.L.D.	B.D.H.	
3	06/11/2010	M.L.D.	K.B.B.	
4	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
5	07/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

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SUFCO Mine
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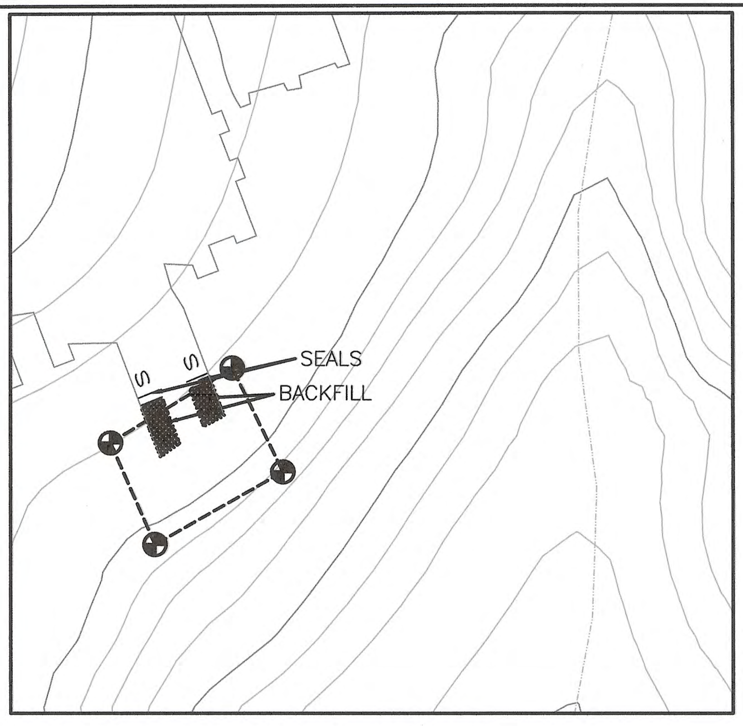
OVERBURDEN ISOPACH MAP

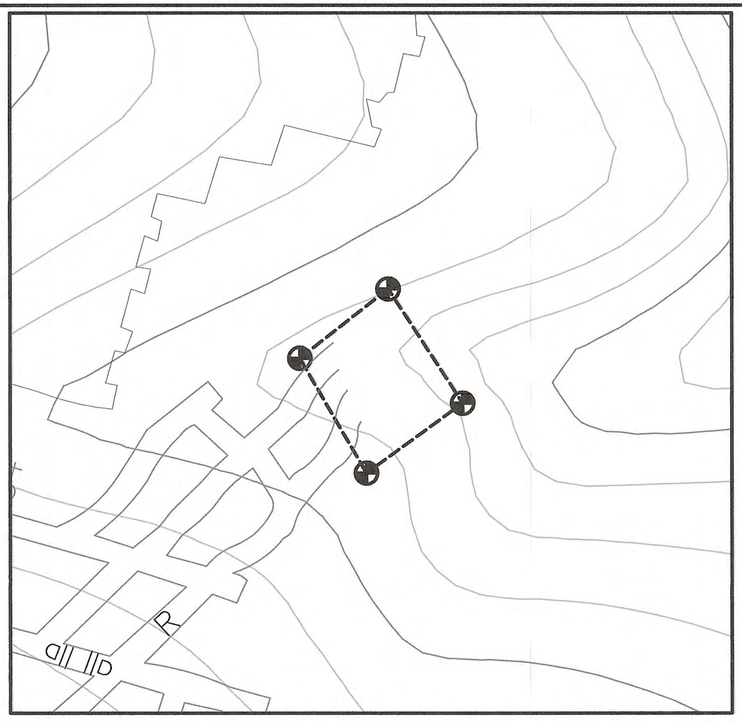
PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-SUFENP1.ctb	1" = 2,000'	8/8/2016	BDH/TRB	JDB	VM	PLATE 5-11

SHT SET: #### PROJECT NUMBER: ####

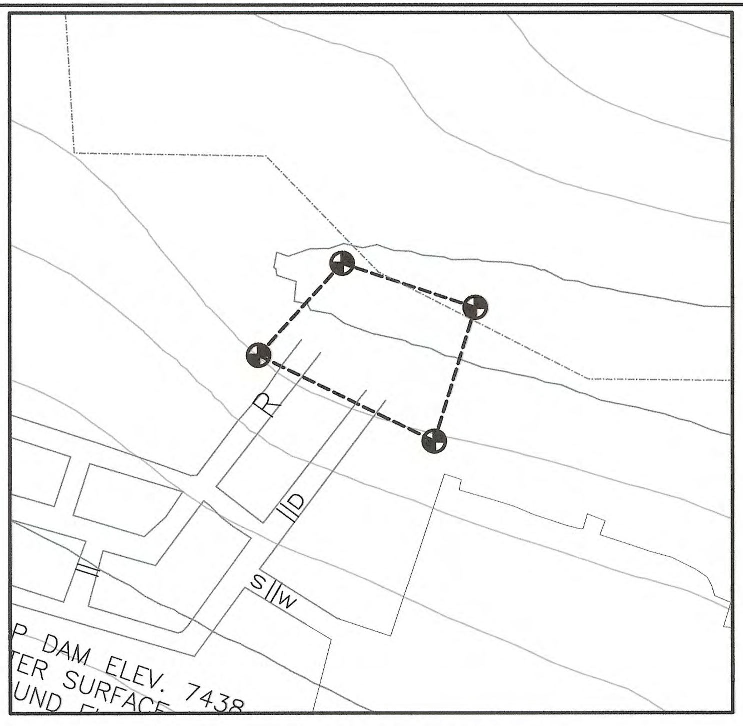
FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4-26-16\PLATE 5-11.dwg



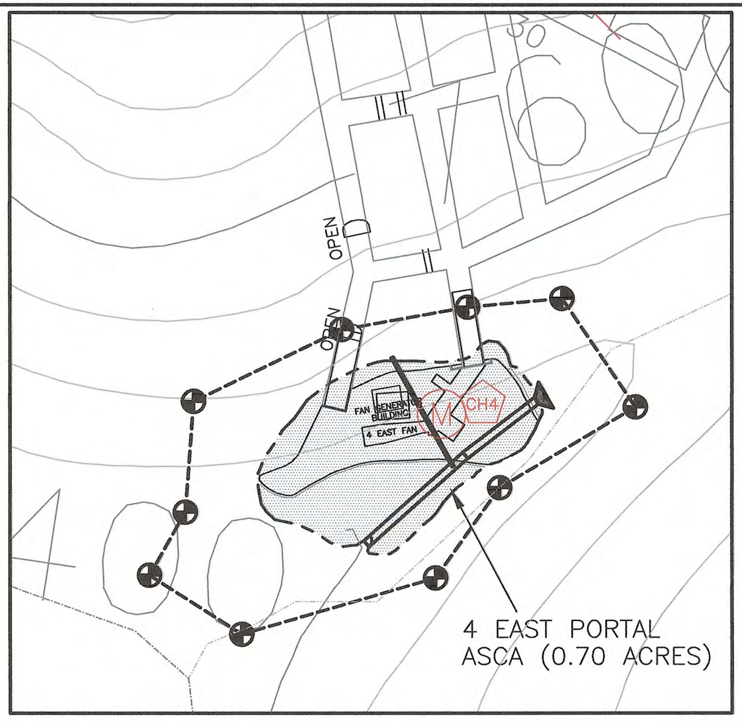
SOUTH PORTALS
SCALE: 1" = 100'



3 EAST PORTALS
SCALE: 1" = 100'

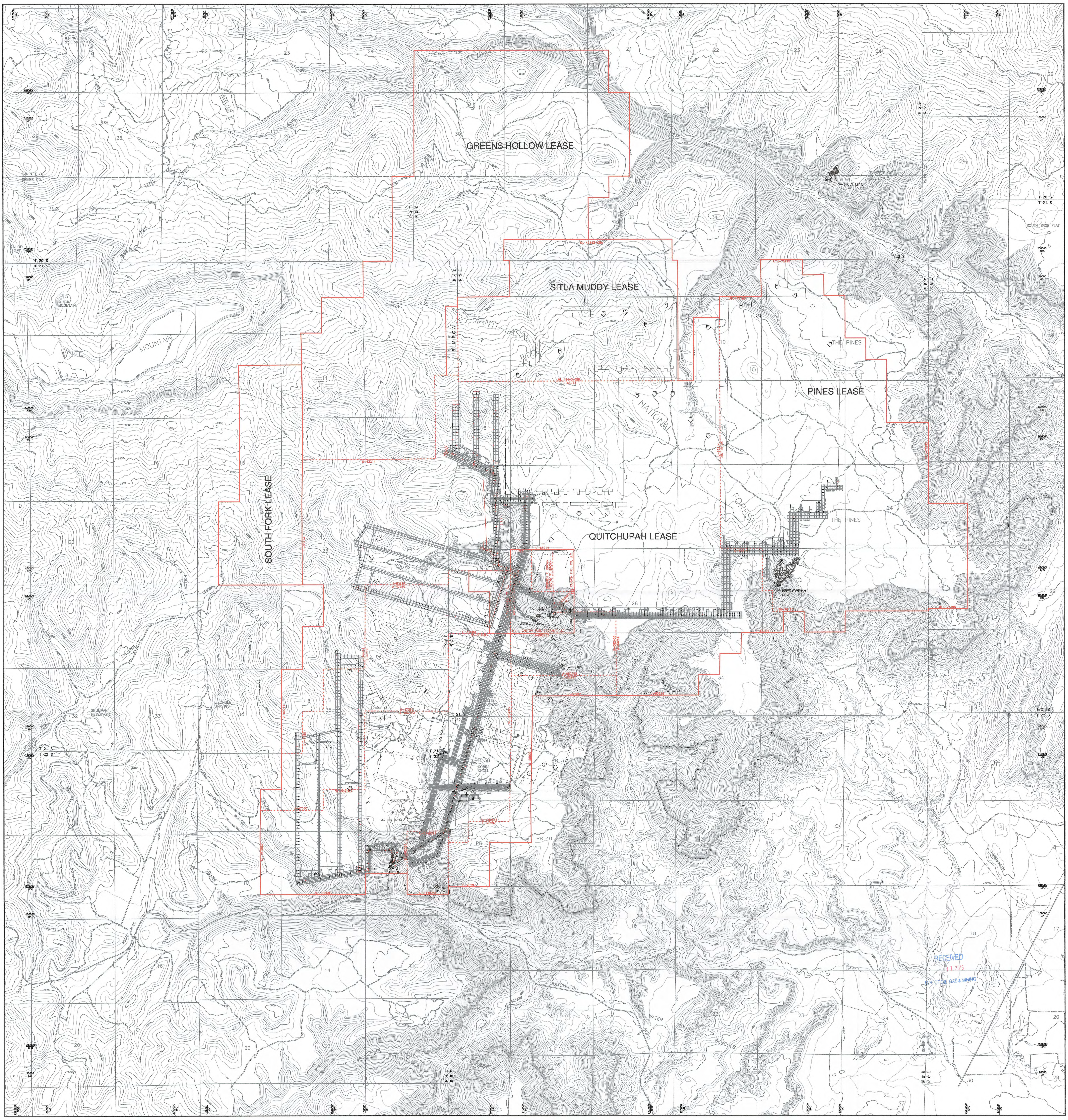


QUITCHUPAH PORTALS
SCALE: 1" = 100'



4 EAST FAN PORTALS
SCALE: 1" = 100'

SURFACE PORTAL FACILITIES – PRE MINING AND POST MINING TOPOGRAPHY



EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- MINE COORDINATES (100000 / MC)
- STATE PLANE COORDINATES (2020000 / SPC)
- STREAM
- ESCARPEMENT
- OUTCROP
- PERENNIAL STREAM
- DISTURBED AREA BOUNDARY
- DISTURBED AREA BOUNDARY MARKER
- DRAIN LINE
- ALTERNATE SEDIMENT CONTROL AREA (ASCA)

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REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
5	03/01/2000	M.L.D.	B.D.H.	
6	11/12/2003	M.L.D.	B.D.H.	
7	06/17/2004	M.L.D.	B.D.H.	
8	05/08/2007	M.L.D.	B.D.H.	
9	05/27/2010	M.L.D.	B.D.H.	
10	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
11	07/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORKLEASE BOUNDARIES

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
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DETAIL OF PORTAL SURFACE FACILITIES

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-SUFENP1.ctb	1" = 2,000'	8/8/2016	B.D.H.		M.L.D.	PLATE 5–2C

SHT SET: #### PROJECT NUMBER: ####
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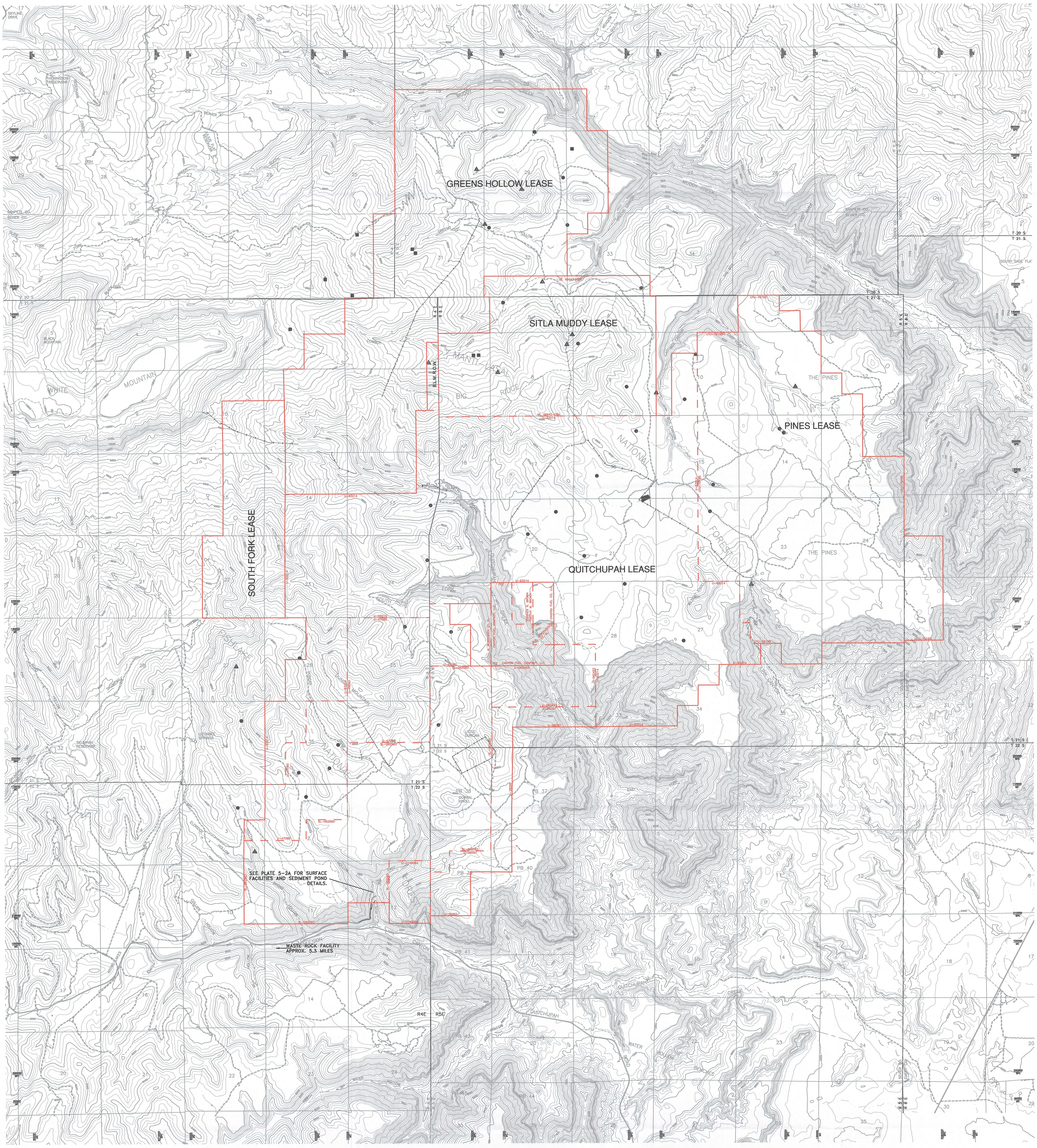

EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- MINE COORDINATES (100000 MC)
- STATE PLANE COORDINATES (2020000 SPC)
- RUNOFF POND
- NATURAL POND
- STOCK WATERING TROUGH
- TRAIL
- UNIMPROVED ROAD
- IMPROVED ROAD
- FENCE

PROFESSIONAL ENGINEER No. 9073281 JACOB D. SMITH STATE OF UTAH 8/9/16

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2000 0 2000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	02/16/1999	M.L.D.	B.D.H.	
2	06/03/1999	M.L.D.	B.D.H.	
3	01/20/2005	M.L.D.	B.D.H.	
4	05/08/2007	M.L.D.	K.B.B.	
5	06/11/2010	M.L.D.	K.B.B.	
6	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
7	07/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

EXISTING SURFACE AND SUBSURFACE FACILITIES AND FEATURES

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_1Stndrd-SUFENP1.ctb	1" = 2,000'	7/26/2016	A.D.D.		J.D.B.	PLATE 5-5

SHT SET:	PROJECT NUMBER:	FILE NAME:
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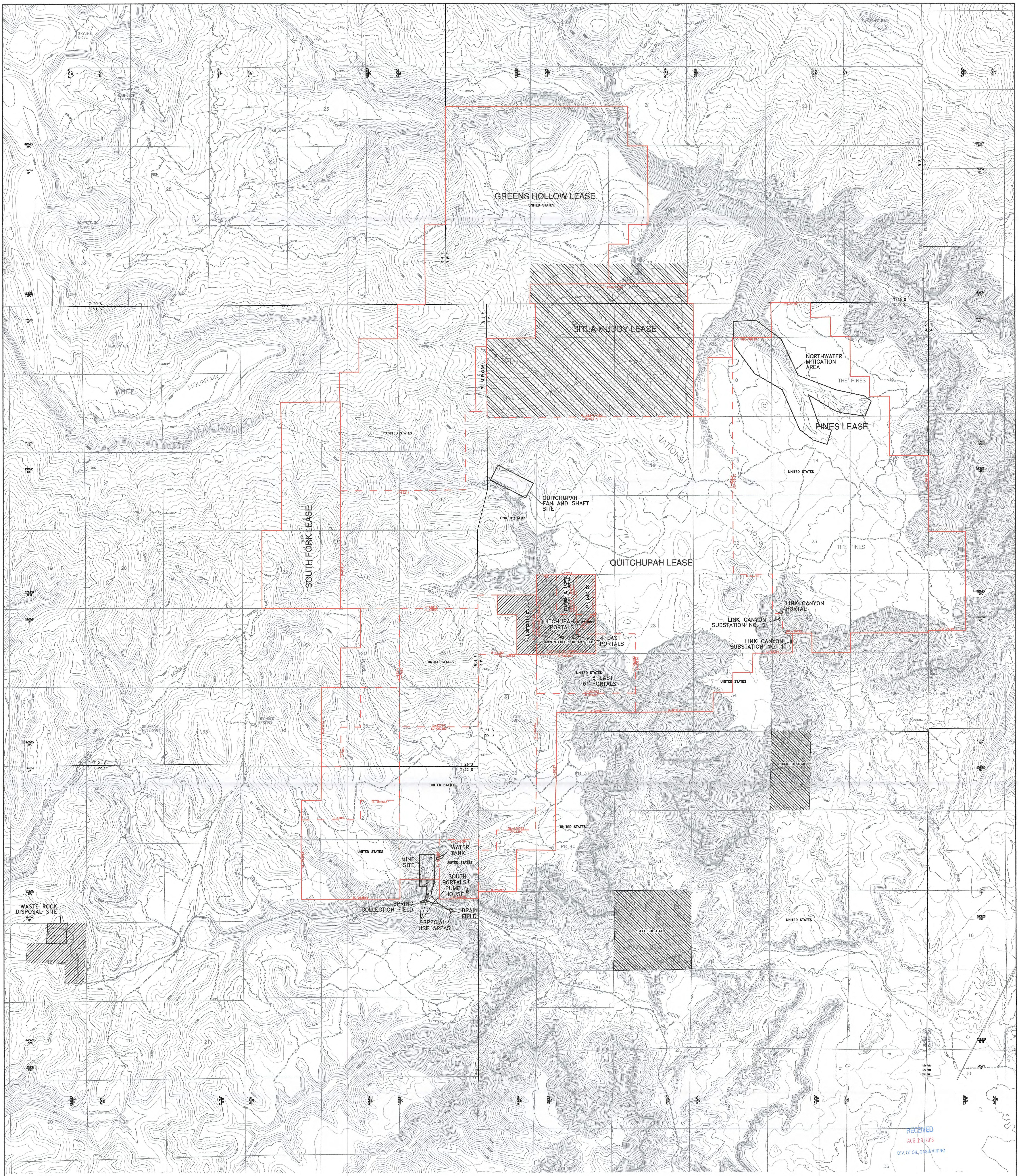
Tmitchell: 7/26/2016 9:33 AM



NOTES:

1. "LEASE AREA" INCLUDES ALL FEDERAL COAL LEASES, STATE COAL LEASES, FEE LANDS AND U.S.F.S. SPECIAL USE PERMIT (SUP) AREAS SHOWN ON THIS MAP.
2. SEE VOLUME 3 REGARDING OWNERSHIP AT WASTE ROCK DISPOSAL SITE.
3. SEE PLATE 5–2A REGARDING MINESITE AREA DETAIL.
4. SEE PLATE 5–2B REGARDING U.S.F.S. SPECIAL USE AREA DETAIL.
5. SEE PLATE 5–2C REGARDING PORTAL AREA DETAIL.
6. SEE PLATE 5–2D REGARDING LINK CANYON SUBSTATION NO. 1 AREA DETAIL.
7. SEE PLATE 5–2E REGARDING LINK CANYON SUBSTATION NO. 2 AREA DETAIL.
8. SEE PLATE 5–2F REGARDING LINK CANYON PORTAL AREA DETAIL.

LAND AND MINERAL OWNERSHIP

LAND	MINERAL
UNITED STATES	STATE OF UTAH
UNITED STATES	UNITED STATES
VARIOUS OWNERS (AS SHOWN)	CANYON FUEL COMPANY, LLC
STATE OF UTAH	UNITED STATES
U.S.F.S. SPECIAL USE AREA	UNITED STATES

EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- PERMIT BOUNDARY
- SPECIAL USE PERMIT BOUNDARY
- 100000 MC — MINE COORDINATES
- 2020000 SPC — STATE PLANE COORDINATES
- DISTURBED AREA BOUNDARY MARKER
- DISTURBED AREA BOUNDARY

LEASE AREA

27,687.48 ACRES FEDERAL COAL LEASES
2,553.84 ACRES UTAH STATE COAL LEASES
640.00 ACRES FEE COAL LEASES
40.00 ACRES WASTE ROCK DISPOSAL SITE
28.50 ACRES U.S.F.S. SPECIAL USE PERMITS
70.00 ACRES B.L.M. RIGHT-OF-WAY
31,019.82 ACRES TOTAL LEASE AREA

ADJACENT AREA

1. BIOLOGY ADJACENT AREA IS A 0.5 MILE BUFFER AROUND ALL SURFACE DISTURBANCES.
2. SEE CHIA FOR HYDROLOGIC ADJACENT AREA BOUNDARY.

PERMIT AREA BOUNDARIES	SITE DESCRIPTION
62.506	SUFCO MAIN FACILITIES COMPLEX
1.595	WATER TANK, EAST SPRING CANYON
0.286	3 EAST PORTALS
1.774	4 EAST PORTALS
0.302	SOUTH PORTALS
0.396	QUITCHUPAH PORTALS
0.287	LINK CANYON SUBSTATION NO. 1
0.245	LINK CANYON SUBSTATION NO. 2
0.380	LINK CANYON PORTAL
41.812	WASTE ROCK DISPOSAL SITE
542.260	NORTH WATER MITIGATION AREA
68.640	QUITCHUPAH FAN & SHAFT SITE
720.483	TOTAL

PERMITTED DISTURBED AREA BOUNDARIES	ACTUAL AREA CURRENTLY DISTURBED TO BE RECLAIMED	SITE DESCRIPTION
30.210	17.405	MINE SITE, EAST SPRING CANYON
0.967	0.39	SPRING COLLECTION FIELD, CONVULSION CANYON
0.220	0.075	PUMP HOUSE, CONVULSION CANYON
0.784	0.40	LEACH FIELD, CONVULSION CANYON
1.595	0.193	WATER TANK, EAST SPRING CANYON
0.286	0.017	3 EAST PORTALS
1.774	0.70	4 EAST PORTALS
0.302	0.017	SOUTH PORTALS
0.396	0.017	QUITCHUPAH PORTALS
0.287	0.18	LINK CANYON SUBSTATION NO. 1
0.245	0.12	LINK CANYON SUBSTATION NO. 2
0.380	0.18	LINK CANYON PORTAL
12.220	11.290	WASTE ROCK DISPOSAL SITE
0.000	0.000	NORTH WATER MITIGATION AREA
0.000	0.000	QUITCHUPAH FAN AND SHAFT SITE
49.666	30.984	TOTAL

PROFESSIONAL ENGINEER
No. 9073281
JACOB D. SMITH
STATE OF UTAH

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2000 0 2000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
15	02/20/2007	M.L.D.	K.B.B.	
16	06/09/2009	M.L.D.	K.B.B.	
17	06/11/2010	M.L.D.	K.B.B.	
18	07/26/2012	M.L.D.	K.B.B.	
19	04/10/2013	M.L.D.	T.R.B.	
20	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
21	07/14/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

LAND OWNERSHIP, LEASE, AND PERMIT AREA MAP

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 2,000'	8/10/2016	JMB/TRB	JDB	VM	PLATE 5–6

FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4–26–16\PLATE 5–6.dwg

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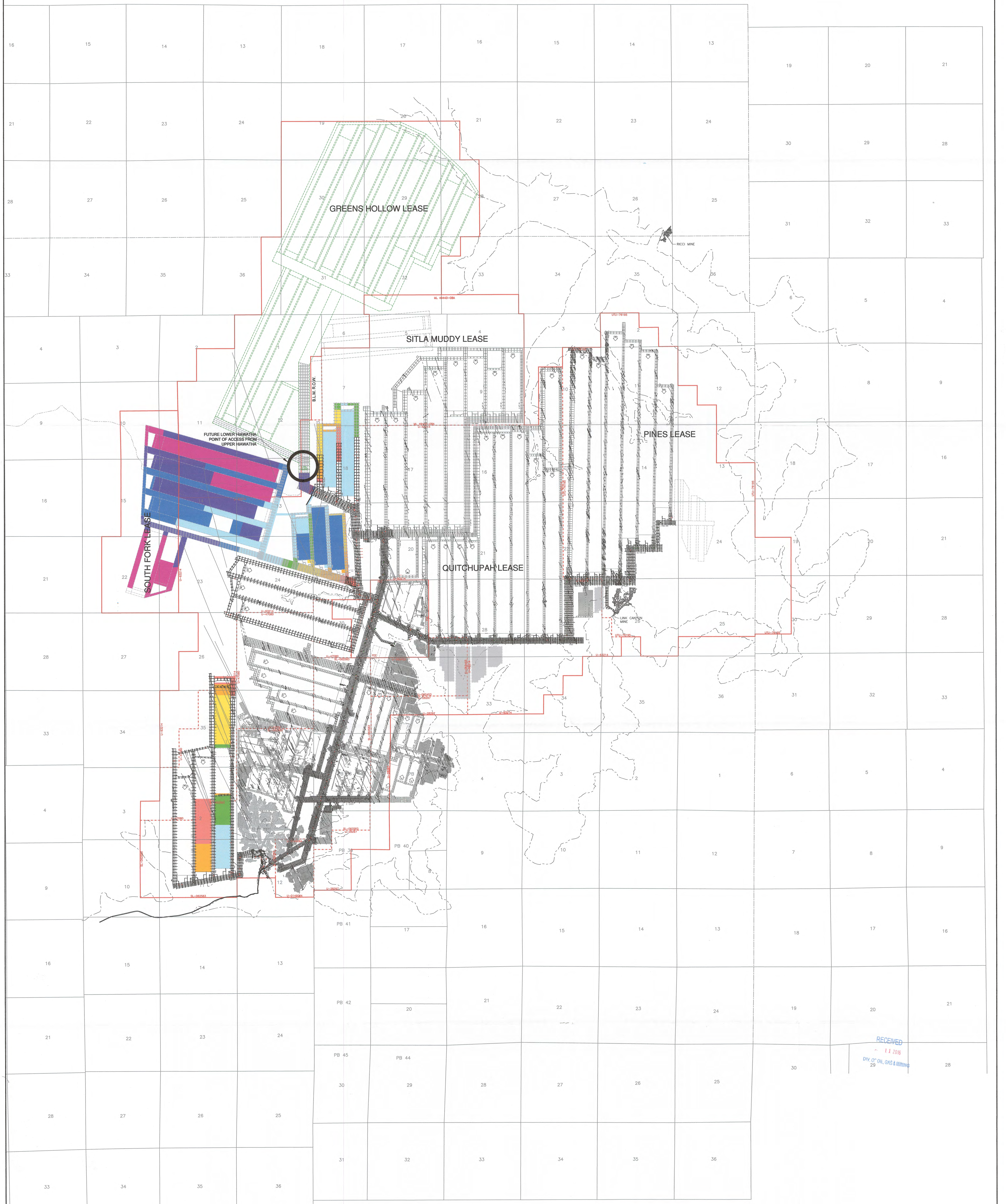

EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- ESCARPEMENT
- OUTCROP

MINING LEGEND

- 1ST QUARTER 2016
- 2ND QUARTER 2016
- 3RD QUARTER 2016
- 4TH QUARTER 2016
- 2017
- 2018
- 2019
- 2020

NOTES:

1. GREENS HOLLOW PROJECTIONS ARE SUBJECT TO FUTURE PERMITTING OF THE GREENS HOLLOW TRACT.

2. ANY PROJECTED MINING SHOWN BEYOND EXISTING LEASE BOUNDARY LINES IS SUBJECT TO FUTURE LEASE MODIFICATIONS AND APPROVALS.

PROFESSIONAL ENGINEER
8/9/16
No. 9073281
JACOB D. SMITH
STATE OF UTAH

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2000 0 2000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
5	05/08/2007	M.L.D.	K.B.B.	
6	08/13/2009	M.L.D.	K.B.B.	
7	05/26/2011	M.L.D.	K.B.B.	
8	03/07/2012	M.L.D.	K.B.B.	
9	03/06/2013	M.L.D.	T.R.B.	
10	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
11	07/14/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286-4880 Phone
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UPPER HIAWATHA MINE PLAN
5 YEAR PROJECTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-SUFENP1.ctb	1" = 2,000'	7/14/2016	BDH/TRB	JDB	VM	PLATE 5-7

SHT SET: #### PROJECT NUMBER: ####

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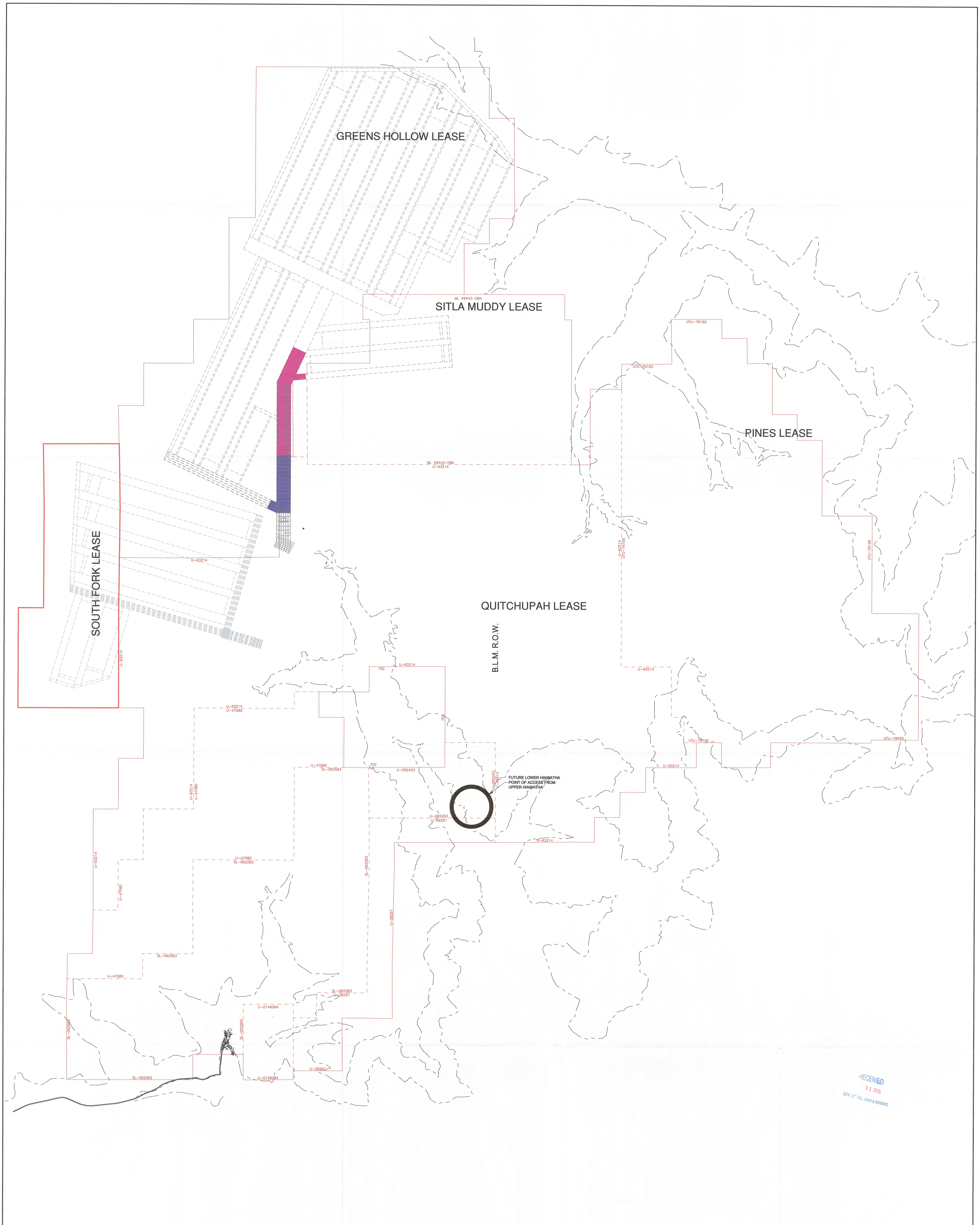

EXPLANATION

U-63214 — SUFCO EXTERIOR LEASE BOUNDARY
SUFCO INTERIOR LEASE BOUNDARY
STREAM
ESCARPEMENT
OUTCROP

MINING LEGEND

1ST QUARTER 2016 (NO PLANNED MINING)
2ND QUARTER 2016 (NO PLANNED MINING)
3RD QUARTER 2016 (NO PLANNED MINING)
4TH QUARTER 2016 (NO PLANNED MINING)
2017 (NO PLANNED MINING)
2018 (NO PLANNED MINING)
2019
2020

PROFESSIONAL ENGINEER
No. 9073281
JACOB D. SMITH
STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

1500 0 1500

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	05/08/2007	M.L.D.	B.D.H.	
2	08/13/2009	M.L.D.	B.D.H.	
3	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
4	07/14/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

LOWER HIAWATHA MINE PLAN
5 YEAR PROJECTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-SUFENP1.ctb	1" = 1,500'	8/9/2016	BDH/TRB	JDB	VM	PLATE 5-8

SHT SET: #### PROJECT NUMBER: ####
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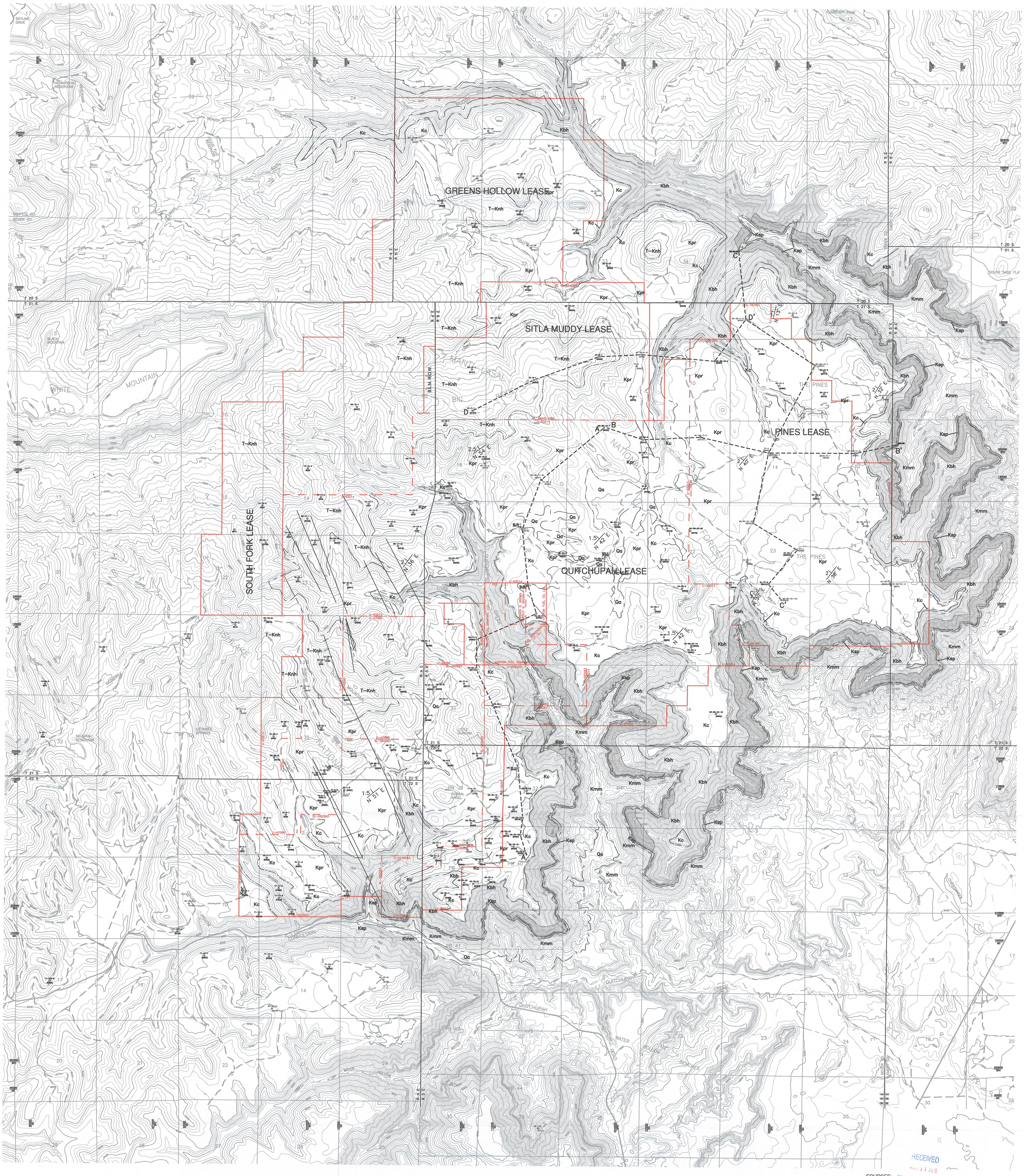
Tmitchell: 8/9/2016 7:03 AM



RECEIVED

DIV. OF OIL, GAS & MINING

SOURCES:

1. QUITCHUPAH LEASE ADDITION, VOLUME 10, MAPS 5.2, 5.3, 6.1, 1989 HYDROMETRICS INC.
   SOUTHERN UTAH FUEL COMPANY'S HYDROLOGICAL RESPONSE TO OSM'S APPARENT COMPLETENESS REVIEW
2. MANTI–LA SAL NATIONAL FOREST–PINES TRACT PROJECT FINAL ENVIRONMENTAL IMPACT STATEMENT (FEIS) FIGURE 3–1 GEOLOGY MAP JANUARY 1999 USDA FOREST SERVICE, REGION FOUR MANTI–LA SAL NATIONAL FOREST EMERY AND SEVIER COUNTIES, UTAH
3. COAL TRACT EVALUATIONS ON THE MANTI–LASAL NATIONAL FOREST MUDDY CREEK AND NORTH HORN SURFACE AND GROUND WATER TECHNICAL REPORTS FIGURE 2 GEOLOGY MAP WITH SPRING LOCATIONS. MUDDY COAL TRACT EIS, EMERY CO. UTAH OCTOBER 2004

NOTE:

1. CONTACTS HAVE NOT BEEN FIELD CHECKED.
2. FAULTS PROJECTED TO SURFACE FROM MINE

EXPLANATION

UPPER HIAWATHA COAL SEAM OUTCROP

EXTERIOR LEASE BOUNDARY

INTERIOR LEASE BOUNDARY

100000 / MC — MINE BASE COORDINATES

2020000 / SPC — STATE PLANE COORDINATES

US–79–2 (8497) — DRILLHOLE LOCATION AND NUMBER, DRILLHOLE SURFACE ELEVATION

FORMATION OR MEMBER CONTACT

FAULTS WITH GREATER THAN 2' DISPLACEMENT MAPPED IN MINE

A'– – – –A — CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

PROPOSED NEWLY BUILT ACCESS ROUTES

PROPOSED ACCESS ROUTES USING EXISTING WHEEL TRACKS OR EXISTING SURFACE

GEOLOGIC KEY

AGE	SYMBOL	NAME
QUATERNARY	Qa	ALLUVIUM, HILL WASH, SLUMPS UNDIFFERENTIATED
TERT–CRET	T–Knh	NORTH HORN FORMATION
CRETACEOUS	Kpr	PRICE RIVER FORMATION
"	Kc	CASTLEGATE SANDSTONE FORMATION
"	Kbh	BLACKHAWK FORMATION–UPPER MEMBER
"	Ksp	BLACKHAWK FORMATION–STARPOINT SANDSTONE MEMBER
"	Kmm	MANCOS SHALE–MASUK MEMBER
	1.5 N 42 E	CALCULATED STRIKE AND DIP TOP UPPER HIAWATHA COAL SEAM
		COAL BURN

PROFESSIONAL ENGINEER
8/9/16
No. 9073281
JACOB D. SMITH
STATE OF UTAH

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N

2000 0 2000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
3	02/19/1999	M.L.D.	B.D.H.	
4	12/10/2001	M.L.D.	B.D.H.	
5	01/20/2005	M.L.D.	B.D.H.	
6	05/08/2007	M.L.D.	K.B.B.	
7	06/11/2010	M.L.D.	K.B.B.	
8	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
9	07/14/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

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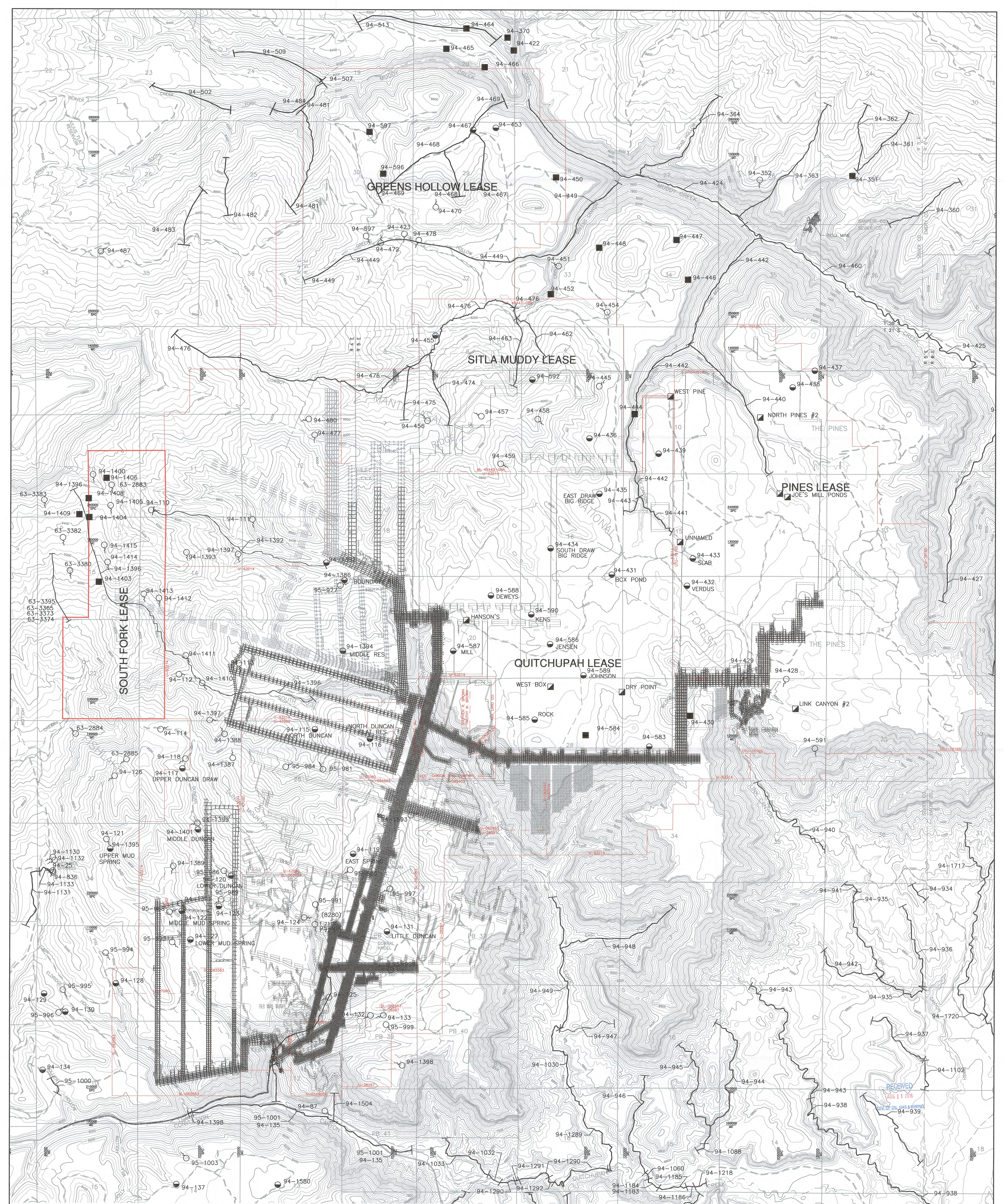
(435) 286–4499 Fax

GEOLOGY & DRILL HOLE LOCATION MAP

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 2,000'	7/27/2016	KJW/TRB	JDB	VM	PLATE 6–1

FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4–26–16\PLATE 6–1.dwg

Tmitchell: 7/27/2016 2:44 PM



EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- 100000 / MC — MINE COORDINATES
- 2020000 / SPC — STATE PLANE COORDINATES
- WATER RIGHT SPRING
- RUNOFF CATCHMENT POND W/ WATER RIGHT
- RUNOFF CATCHMENT POND W/O WATER RIGHT
- SURFACE WATER RIGHT POINT TO POINT
- SURFACE WATER RIGHT

NOTES:

1. SEE APPENDIX 7–1 FOR DETAILED LISTING OF WATER RIGHTS

Tmitchell: 7/26/2016 1:59 PM

QUITCHUPAH TRACT

CATCHMENT PONDS WITH WATER RIGHTS NUMBER	NAME	CURRENT COMMON NAME USED BY USFS, CATTLEMEN AND OTHERS	OTHER HISTORICAL NAMES USED FOR CATCHMENT PONDS
94–115	NORTH DUNCAN RES.		
94–116	NORTH DUNCAN FLAT RES.		
94–117	UPPER DUNCAN DRAW RES.		
94–119	EAST SPRING RES.		
94–120	LOWER DUNCAN RES.		
94–122	MIDDLE MUD SPRING RES.		
94–123	SHORT HOLLOW RES.		
94–127	LOWER MUD SPRING RES.		
94–128	PIN HOLLOW RES.		
94–129	ELDRIDGE HOLLOW RES. #1		
94–130	ELDRIDGE HOLLOW RES. #2		
94–131	LITTLE DUNCAN RES.		
94–134	COLLIER RES.		
94–137	JOLLY MILL POINT RES.		
94–430	UNNAMED RES.	LINK CANYON #1	
94–431	UNNAMED RES.	BOX POND	TRIANGLE, THREE CORNER
94–434	UNNAMED RES.	SOUTH DRAW BIG RIDGE	
94–435	UNNAMED RES.	EAST DRAW BIG RIDGE	
94–436	UNNAMED RES.		
94–439	UNNAMED RES.		

QUITCHUPAH TRACT

CATCHMENT PONDS WITH WATER RIGHTS NUMBER	NAME	CURRENT COMMON NAME USED BY USFS, CATTLEMEN AND OTHERS	OTHER HISTORICAL NAMES USED FOR CATCHMENT PONDS
94–444	UNNAMED RES.		
94–583	DRY POINT RES.		
94–584	SEEPS RES.	SEEPS POND	
94–585	WHITE KNOLL RES.	ROCK POND	
94–586	BOX CANYON RES.	JENSEN	
94–587	MILL RES.	MILL POND	
94–588	DWEYS RES.	DEWYS POND	
94–589	SAGE CREEK RES.	JOHNSON POND	JENSEN, SAGE GROUSE POND
94–590	KENS RES.		
94–592	BIG RIDGE RES.		
94–730	QUITCHUMPAH RES. #1	QUITCHUPAH RES. #1	
94–1386	BOUNDARY RES.		
94–1394	MIDDLE RES.		
94–1395	UPPER MUD SPRINGS RES.		
94–1401	MIDDLE DUNCAN RES.		
94–1580	JOLLY MILL GUZZLER RES.		
OTHER CATCHMENT PONDS WITHOUT WATER RIGHTS			
		WEST BOX	
		DRY POINT	
		HANSON'S POND	JOHNSON, HANS

PROFESSIONAL ENGINEER No. 9073281 JACOB D. SMITH STATE OF UTAH 8/4/16

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

1500 0 1500

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	7/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES; COMBINE 7–2A,B,C DRAWINGS

PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

SURFACE AND GROUNDWATER RIGHTS–QUITCHUPAH TRACT

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 1,500'	7/26/2016	J.G.C	V.M.	V.M.	PLATE 7–2

FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4–26–16\PLATE 7–2.dwg

NOTES:

1. HISTORIC STREAM, SPRING AND WELL MONITORING SITES ARE OLD BASELINE MONITORING SITES OR SITES THAT HAVE BEEN DISCONTINUED OR MINED THROUGH THAT ARE NOT CURRENTLY BEING MONITORED.

EXPLANATION

- SUFCO MINE EXTERIOR LEASE BOUNDARY
- SUFCO MINE INTERIOR LEASE BOUNDARY
- 100000 / MC — MINE COORDINATES
- 2020000 / SPC — STATE PLANE COORDINATES
- HISTORIC STREAM
- STREAM MONITORING
- HISTORIC MONITORING WELL
- MONITORING WELL SITE
- HISTORIC SPRING MONITORING SITE
- SPRING MONITORING
- UPDES MONITORING POINT
- IN MINE MONITORING SITE
- (7600) ELEVATION OF SITE
- PERENNIAL FLOW LOCATION MONITORING POINT
- PERENNIAL FLOWS
- SPRING NOT MONITORED

PROFESSIONAL ENGINEER
No. 9073281
JACOB D. SMITH
STATE OF UTAH
8/9/16

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1000 0 1000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
14	05/08/2009	M.L.D.	K.B.B.	
15	05/13/2009	M.L.D.	K.B.B.	
16	06/11/2010	M.L.D.	K.B.B.	
17	01/02/2013	M.L.D.	K.B.B./T.R.B.	
18	05/30/2013	V.M.	T.R.B.	
19	03/02/2015	V.M.	T.R.B.	ADDED 70ACRE R.O.W. AREA FOR 5 WEST
20	07/14/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

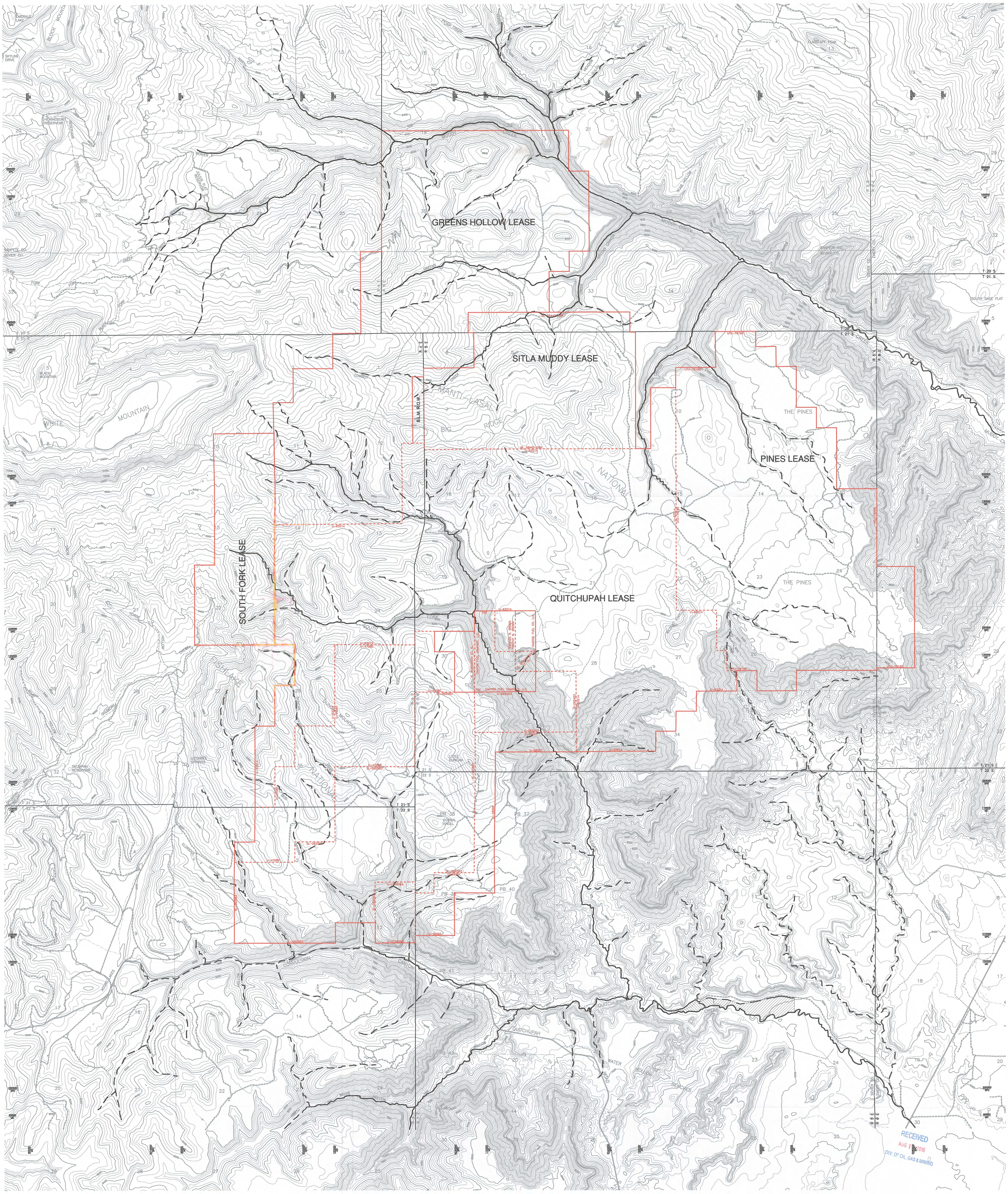
PEN TBL: _1Stndrd-SUFENP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

Canyon Fuel Company, LLC
SUFCO Mine
597 South SR 24 – Salina, UT 84654
(435) 286-4880 Phone
(435) 286-4499 Fax

HYDROLOGIC MONITORING STATIONS

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 1,000'	8/4/2016	JMB/TRB	J.D.B.	V.M.	PLATE 7-3

FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4-26-16\PLATE 7-3.dwg



EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- 100000 MC — MINE COORDINATES
- 2020000 SPC — STATE PLANE COORDINATES
- EPHEMERAL OR INTERMITTANT FLOWS
- PERENNIAL FLOWS
- IRRIGATION DITCH
- POTENTIALLY FLOOD IRRIGATED
- FLOOD IRRIGATED

SOURCES:

1. QUITCHUPAH TRACT
   HYDROMETRICS, INC.
   SOUTHERN UTAH FUEL COMPANY'S
   HYDROLOGICAL RESPONSE TO OSM'S APPARENT
   COMPLETENESS REVIEW, NOV. 1, 1980

2. PINES TRACT
   MANTI–LA SAL NATIONAL FOREST–PINES TRACT PROJECT
   FINAL ENVIRONMENTAL IMPACT STATEMENT (FEIS)
   FIGURE 3–11 SPRINGS, SEEPS, AND RIPARIAN AREAS
   JANUARY 1999
   USDA FOREST SERVICE, REGION FOUR
   MANTI–LA SAL NATIONAL FOREST
   EMERY AND SEVIER COUNTIES, UTAH

PROFESSIONAL ENGINEER
8/9/16
No. 9073281
JACOB D. SMITH
STATE OF UTAH

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REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	2/18/1999	M.L.D.	A.D.D.	
2	03/01/2000	W.K.S.	A.D.D.	
3	5/8/2007	M.L.D.	A.D.D.	
4	03/02/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR 5 WEST
5	07/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES

Canyon Fuel Company, LLC
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ALLUVIAL VALLEY FLOOR CHARACTERISTICS DETERMINATION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_1Stndrd-SUFENP1.ctb	1" = 2,000'	7/27/2016	ADD/TRB	JDB	VM	PLATE 9-1

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FILE NAME: H:\DRAWINGS\MRP\PLATES_Proposed 4-26-16\PLATE 9-1.dwg

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