



GARY R. HERBERT  
Governor

GREGORY S. BELL  
Lieutenant Governor

# State of Utah

## DEPARTMENT OF NATURAL RESOURCES

MICHAEL R. STYLER  
Executive Director

### Division of Oil, Gas and Mining

JOHN R. BAZA  
Division Director

November 9, 2012

Outgoing  
C0150032  
#4163  
OC

David Hibbs, Resident Agent  
Genwal Resources, Inc.  
P.O. Box 910  
East Carbon, Utah 84520-0910

Subject: Final Approval of Construction of Burma Evaporation Pond and Revised Permit Document, Genwal Resources, Inc., Crandall Canyon Mine, C/0015/0032, Task ID #4163

Dear Mr. Hibbs:

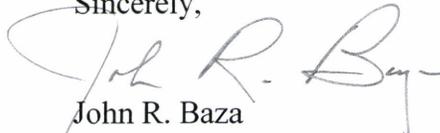
On October 22, 2012, the Division conditionally approved your application, upon receipt of clean copies, for Construction of the Burma Evaporation Pond which also included a change in the permit boundary for the Crandall Canyon Mine. We received the clean copies on November 2, 2012. The Burma Evaporation Pond Revision hereby receives final approval. Enclosed is a stamped incorporated copy for insertion into your copy of the Mining and Reclamation Plan

Also enclosed along with the Division's Decision Document are two (2) copies of the revised permanent program permit for the Crandall Mine, which include the Burma pond. Please have both permits signed by the designated signatory authority and return one signed copy to the Division. You should note the permit conditions and that the expiration date of the permit did not change but remains May 13, 2013.

We also remind you of your commitment found on page 11 of Appendix 7-65, that the Burma Evaporation Basin must be constructed and operational within 60 days of the date of this letter. Additionally, the continued use of the primary sediment pond at the Crandall Canyon Mine for iron sludge disposal will no longer be authorized at that time. Failure to meet these permit commitments will result in enforcement action.

Thank you for your help in completing this important permitting action. If you have any questions, please call me at (801) 538-5334 or Daron Haddock at (801)538-5325.

Sincerely,

  
John R. Baza  
Director

JRB/DRH/sqs  
Enclosure

cc: Kenneth Walker, OSM  
Jeff McKenzie, BLM  
Kevin Carter, TLA  
Price Field Office

O:\015032.CRA\PERMIT\2012Revised\Permit.docm

File in:

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Outgoing



**UTAH DIVISION OF OIL, GAS AND MINING  
STATE DECISION DOCUMENT  
For  
Construction of Burma Evaporation Pond**

**Genwal Resources, Inc.  
Crandall Canyon Mine  
C/015/0032  
Emery County, Utah**

**November 9, 2012**

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- Permit Area Maps
- Permitting Chronology
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## **ADMINISTRATIVE OVERVIEW**

Genwal Resources, Inc.  
Crandall Canyon Mine  
Construction of Burma Evaporation Pond  
C/015/0032  
Emery County, Utah

November 9, 2012

### **PROPOSAL**

Genwal Resources, Inc. has proposed to construct an evaporation basin to aid in the disposal of iron sludge material currently produced at the Crandall Canyon mine site. The project is planned to be built on 7.32 acres of SITLA property located near the mouth of Huntington Canyon in Emery County, Utah in Lot 6, Section 5, Township 17 South, Range 8 East, Salt Lake base meridian.

### **BACKGROUND**

The Crandall Canyon Mine is currently discharging water that is above the UPDES compliance limit for iron. The company has constructed a water treatment facility at the minesite to reduce the iron concentration to within acceptable discharge levels. The facility utilizes an aeration unit, a chemical injection system to coagulate and flocculate the precipitated iron, and a settling basin to allow the precipitated iron to accumulate. While the treatment facility has provided a means whereby they can legally discharge the mine water, the Company now needs a location for desiccating and disposal of the iron sludge. This evaporation basin will provide the means and location for the disposal of the iron sludge material.

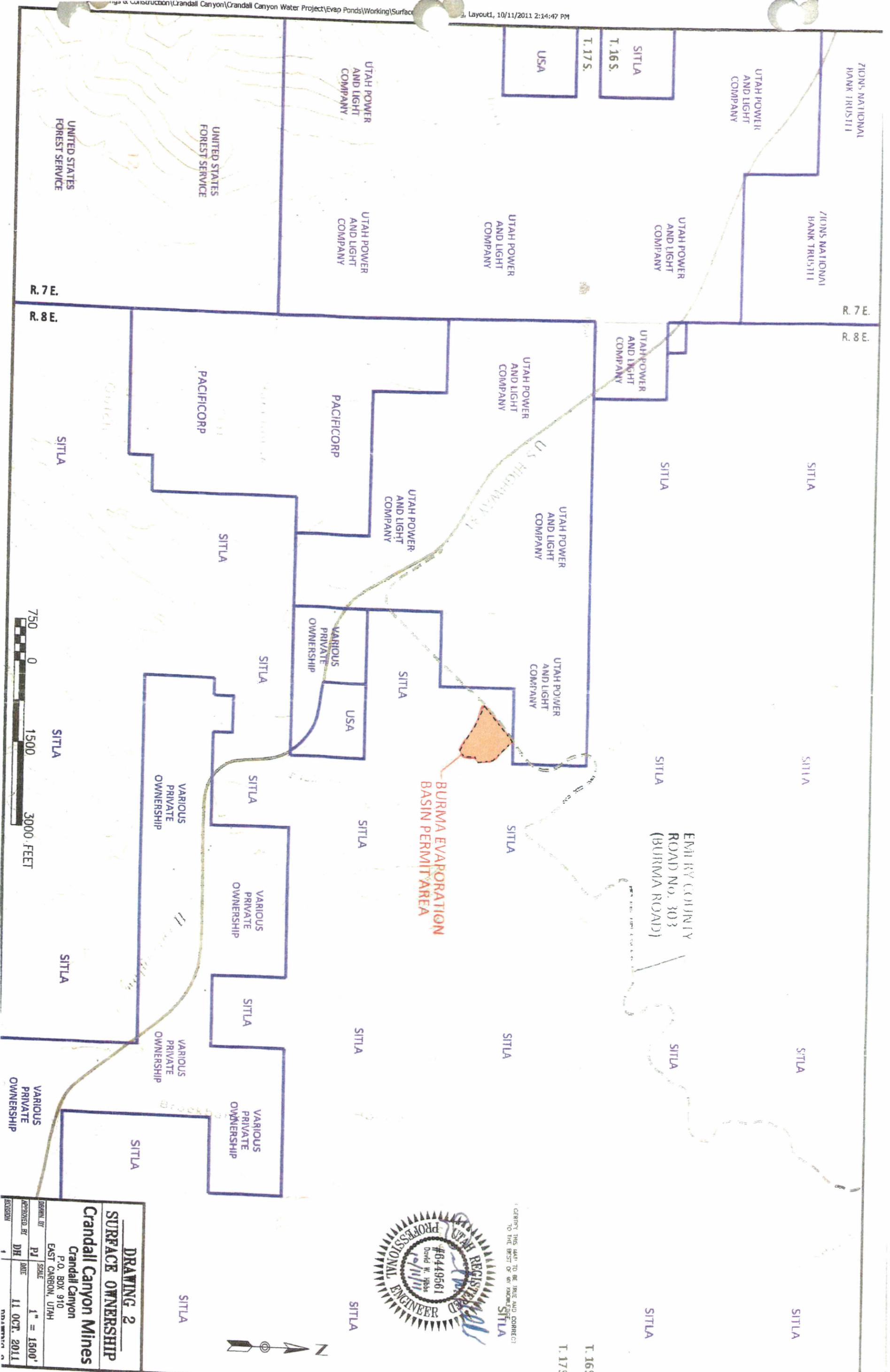
### **ANALYSIS**

The Burma Evaporation pond is considered to be an installation which facilitates mining and reclamation operations, therefore it requires a permit under the Surface Mining Control and Reclamation Act (SMCRA). Genwal Resources has provided a complete and accurate application for obtaining a permit for the pond. A notice was published in the Emery County Progress and the Carbon County Sun Advocate advertising the proposal and giving the public opportunity to comment. Pertinent State, Federal and local agencies were also afforded the opportunity to comment and participate in the permitting process. A technical review was completed by the DOGM staff which found that the application is complete and accurate. A revised Cumulative Hydrologic Impact Assessment has also been completed that has determined that the proposed coal mining and reclamation operations have been designed to prevent material damage to the hydrologic balance outside of the permit area. A review of the bond has also determined that there is adequate bond in place to provide for the reclamation of the Burma Evaporation pond.

## **RECOMMENDATION**

Genwal Resources, Inc. has completed all of the requirements for revising their mining and reclamation permit to include the Burma evaporation pond. It is recommended that a revised permit be issued with the following stipulation: Prior to the final disposal of the iron sludge in the Burma pond, Genwal Resources, Inc. will need to obtain authorization to do so from the Department of Environmental Quality Division of Solid & Hazardous Waste through the permit by rule process.





I CERTIFY THIS PLAN TO BE MADE AND CORRECT TO THE BEST OF MY KNOWLEDGE

**DRAWING 2**  
**SURFACE OWNERSHIP**  
**Crandall Canyon Mines**  
 Crandall Canyon  
 P.O. BOX 910  
 EAST CARBON, UTAH

DESIGNED BY	PJ	SCALE	1" = 1500'
APPROVED BY	DH	DATE	11 OCT. 2011

REVISION 1

## PERMITTING CHRONOLOGY

Genwal Resources, Inc.  
Crandall Canyon Mine  
Construction of Burma Evaporation Pond  
C/015/0032  
Emery County, Utah

November 9, 2012

January 12, 2012	Genwal Resources, Inc. submitted an application for Construction of the Burma Evaporation Pond.
January 24, 2012	AVS is queried and there were no violations identified.
February 1, 2012	The Division determines the application to be administratively complete.
February 1, 2012	The Division notifies agencies of intent to Construct Burma Evaporation Pond and solicits their comments.
February 14, 21, 27 and March 6, 2012	Publication commences in the Emery County Progress and the Carbon County Sun Advocate for the Construction of the Burma Evaporation Pond at the Crandall Canyon Mine.
April 5, 2012	End of public comment period. No comments received.
April 20, 2012	The Division identifies deficiencies to be addressed by Genwal Resources, Inc.
June 22, 2012	Genwal Resources, Inc. addresses deficiencies identified by the Division.
August 8, 2012	The Division identifies additional deficiencies to be addressed by Genwal Resources, Inc.
September 5, 2012	Genwal Resources, Inc. addresses deficiencies identified by the Division.
October 22, 2012	Conditional Approval of the submittal is issued.

November 2, 2012	Division receives clean copies of the revision.
November 2, 2012	AVS, 510c Recommendation, no violations.
November 9, 2012	Final approval of the Construction of the Burma Evaporation Pond is given and a revised permit issued effective November 9, 2012.

## FINDINGS

Genwal Resources, Inc.  
Crandall Canyon Mine  
Construction of Burma Evaporation Pond  
C/015/0032  
Emery County, Utah

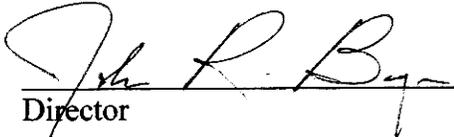
November 9, 2012

1. The revised plan and the permit application are accurate and complete and all requirements of the Surface Mining Control and Reclamation Act, and the approved Utah State Program (the "Act") have been compiled with (R645-300-133.100). See attached Technical Analysis dated November 5, 2012.
2. The applicant proposes to construct an evaporation basin on 7.32 acres for the disposal of iron sludge produced at the Crandall Canyon Mine site. The Division has determined that reclamation, as required by the Act can be feasibly accomplished by following the approved plan. See Technical Analysis dated November 5, 2012.
3. The assessment of the probable cumulative impacts of all anticipated coal mining and reclamation activities in the general area on the hydrologic balance has been conducted by the regulatory authority and no significant impacts or material damage findings were identified. The Mining and Reclamation Plan (MRP) proposed under the application has been designed to prevent damage to the hydrologic balance in the permit area and in associated off-site areas (R645-300-133.400 and UCA 40-10-11 {2}{c}). See attached Cumulative Hydrologic Impact Analysis [CHIA] updated November 6, 2012.
4. The proposed lands to be included in the permit area are:
  - a. Not included within an area designated unsuitable for coal mining operations (R645-300-133.220)
  - b. not within an area under study for designation as lands unsuitable for coal mining and reclamation operations. (R645-300-133.210)
  - c. not on any lands subject to the prohibitions or limitations of 30 CRF 761.11 {a} (national parks, etc.), 761.11 {f} (public buildings, etc.) and 761.11 {g} (cemeteries);
  - d. not within 100 feet of a public road (R645-300-133.220); and
  - e. not within 300 feet of any occupied dwelling (R645-300-133.220).
5. The operation would not affect the continued existence of any threatened or endangered species or result in the destruction or adverse modification of their critical habitats as determined under the Endangered Species Act of 1973 (R645-300-133.500).
6. The Division's issuance of a permit is in compliance with the National Historic Preservation Act and implementing regulations (36 CFR 800) (R645-300-133.600).
7. The applicant has the legal right to enter and complete activities through a Special Use Lease issued by SITLA (Lease #1708).

8. A 510(c) report has been run on the Applicant Violator System (AVS), which shows that: prior violations of applicable laws and regulations have been corrected; neither Genwal Resources, Inc. or any affiliated company are delinquent in payment of fees for the Abandoned Mine Reclamation Fund; and the applicant does not control and has not controlled mining operations with a demonstrated pattern of willful violations of the Act of such nature, duration, and with such resulting irreparable damage to the environment as to indicate an intent not to comply with the provisions of the Act (R645-300-133.730). See attached memo dated November 2, 2012.
9. Mining operations to be performed under the permit will not be inconsistent with other operations anticipated to be performed in area adjacent to the proposed permit area.
10. The applicant has posted financial assurance for the Crandall Canyon Mine in the amount of \$2,327,275. (Bond #14-96-15 issued by American Home Assurance Company \$1,654,000, Bond #ISM-2877 issued by Rockwood Casualty Insurance Company \$266,000, Bond #ISB-2952 issued by Rockwood Casualty Insurance Company, Bond #ISM-2953 issued by Rockwood Casualty Insurance Company, Bond #ISM-2954 issued by Rockwood Casualty Insurance Company). No additional surety will be required.
11. No lands designated as prime farmlands or alluvial valley floors occur on the permit area (R645-302-313.100 and R645-302-321.100).
12. The proposed post-mining land-use of the permit area is the same as the pre-mining land use and has been approved by the Division and Land owner.
13. The Division has made all specific approvals required by the Act and the Cooperative Agreement.
14. All procedures for public participation required by the Act, and the approved State Program are in compliance. The public advertisement was placed in the Emery County Progress as well as the Carbon County Sun Advocate on February 14, 21, 27 and March 6, 2012. No comments were received (R645-300-120).
15. No existing structures will be used in conjunction with the construction of the Burma pond (R645-300-133.720).

  
\_\_\_\_\_  
Permit Supervisor

  
\_\_\_\_\_  
Associate Director of Mining

  
\_\_\_\_\_  
Director

**AFFIDAVIT OF PUBLICATION**

STATE OF UTAH)

ss.

County of Carbon,)

I, Richard Shaw, on oath, say that I am the Publisher of the Sun Advocate, a twice-weekly newspaper of general circulation, published at Price, State of Utah a true copy of which is hereto attached, was published in the full issue of such newspaper for 4 (Four) consecutive issues, and on the Utah legals.com website, the first publication was on the 14th day of February, 2012, and that the last publication of such notice was in the issue of such newspaper dated the 6th day of March 2012.

*Richard Shaw*

Richard Shaw - Publisher

Subscribed and sworn to before me this 6th day of March, 2012.

*Linda Thayne*

Notary Public My commission expires January 10, 2015 Residing at Price, Utah

Publication fee, \$ 201.60



**PUBLIC NOTICE FOR PERMIT REVISION  
CRANDALL CANYON MINE**

Genwal Resources, Inc., P.O. Box 910, East Carbon, Utah 85520, has filed with the Utah Division of Oil, Gas and Mining an application to revise the Crandall Canyon Mine Mining and Reclamation Plan (C/015/032). This revision would add 7.32 acres to the existing 6787.74 acre permit area for the purpose of construction an evaporation basin (a.k.a. the Burma Evaporation Basin) to be used as part of the treatment facility for the mine discharge water. Specifically, the basin would be located on SITLA land in lower Huntington Canyon in Lot 6, Section 5, T17S, R8E, SLBM. Copies of this application are available for inspection at the Division of Oil, Gas and Mining, 1594 West Temple, Suite 1210, Salt Lake City, Utah and at the Emery County Courthouse, 75 East Main, Emery, Utah. Comments, objections or requests for an informal conference should be addressed to the Utah Division of Oil, Gas and Mining, 1594 West Temple, Suite 1210, P.O. Box 145801, Salt Lake City, Utah 84114-5801.  
Published in the Sun Advocate February 14, 21, 28 and March 6, 2012.

**AFFIDAVIT OF PUBLICATION**

STATE OF UTAH)

ss.

County of Emery,)

I, Richard Shaw, on oath, say that I am the Publisher of the Emery County Progress, a weekly newspaper of general circulation, published at Castle Dale, State of Utah and County aforesaid, and that a certain notice, a true copy of which is hereto attached, was published in the full issue of such newspaper for 4 (Four) consecutive issues, and on the Utah legals.com website; the first publication was on the 14th day of February, 2012, and that the last publication of such notice was in the issue of such newspaper dated the 6th day of March, 2012.



Richard Shaw - Publisher

Subscribed and sworn to before me this 6th day of March 2012.



Notary Public My commission expires January 10, 2015 Residing at Price, Utah

Publication fee, \$ 144.00



**PUBLIC NOTICE FOR PERMIT REVISION  
GRANDALL CANYON MINE**

Grandall Resources, Inc. (P.O. Box 910, East Carbon, Utah 85820) has filed with the Utah Division of Oil, Gas and Mining in application to revise the Grandall Canyon Mine Mining and Reclamation Plan (C-0150122). This revision would add 7.32 acres to the existing 9787.74 acre permit area for the purpose of construction of an evaporation pond (E.P.) for brine evaporation. This E.P. is to be used as part of the treatment facility for the mine discharge water. Specifically, the pond would be located on BTLA land in lower Huntington Canyon in Lot 0, Section 5, T17N, R05E, G1M4, of the 4th Meridian and would be for inspection by the Division of Oil, Gas and Mining, 1504 West Temple, Salt Lake City, Utah, and the Emery County Commission, 15 East Main, Emery, Utah. Comments, objections or requests for an informal conference should be addressed to the Utah Division of Oil, Gas and Mining, 1504 West Temple, Salt Lake City, Utah 84114-5801.

Published in the Emery County Progress February 14, 21, 27 and March 6, 2012.

**FEDERAL**

**PERMIT  
C/015/0032**

**November 9, 2012**

**STATE OF UTAH  
DEPARTMENT OF NATURAL RESOURCES  
DIVISION OF OIL, GAS AND MINING  
1594 West North Temple, Suite 1210  
Salt Lake City, Utah 84114-5801  
(801) 538-5340**

This permit, C/015/0032, is issued for the state of Utah by the Utah Division of Oil, Gas and Mining ('DOGM') to:

**Genwal Resources, Inc.  
P.O. Box 910  
East Carbon, Utah 84520-0910  
(435) 888-4476**

for the Crandall Canyon Mine. Genwal Resources, Inc. is the lessee of federal, state and fee-owned property. Special use permits have also been granted by the Forest Service which allow Genwal Resources, Inc. to conduct mining operations on other federal lands. A performance bond is filed with the DOGM in the amount of \$2,327,275.00, payable to the state of Utah, Division of Oil, Gas and Mining and the Office of Surface Mining Reclamation and Enforcement ('OSMRE'). Evidence of an additional bond in the amount of \$720,000.00 has been submitted. This additional bond is filed to cover the perpetual treatment of mine water discharge. Total bond for this mine is \$3,047,275. DOGM must receive a copy of this permit signed and dated by the Permittee.

**Sec. 1 STATUTES AND REGULATIONS** - This permit is issued pursuant to the Utah Coal Mining and Reclamation Act of 1979, Utah Code Annotated (UCA) 40-10-1 et seq, hereafter referred to as the Act.

**Sec. 2 PERMIT AREA** - The Permittee is authorized to conduct coal mining and reclamation operations on the following described lands within the permit area at the Crandall Canyon Mine situated in the state of Utah, Emery County, and located:

**Township 15 South, Range 6 East, SLBM**

Section 25: S 1/2  
Section 26: S 1/2  
Section 35: All  
Section 36: All

**Township 15 South, Range 7 East, SLBM**

Section 30: Lots 7-12, SE 1/4  
Section 31: Lots 7-12, NE1/4, N1/2SE1/4, SW1/4SE1/4, SE1/4SE1/4

Section 32: W1/2NW1/4, NW1/4SW1/4, S1/2SW1/4, SW1/4SE1/4

**Township 16 South, Range 6 East, SLBM**

Section 1: Lots 1-12, SW 1/4  
Section 2: All  
Section 3: E1/2E1/2SE1/4NE1/4, E1/2E1/2NE1/4SE1/4, E1/2SE1/4SE1/4  
Section 10: NE1/4NE/4NE1/4

**Township 16 South, Range 7 East, SLBM**

Section 4: W1/2SW1/4, S1/2SW1/4NW1/4  
Section 5: Lots 2, 3, 5, 6 and 8, SE1/4, S1/2SE1/4NE1/4, SW1/4  
Section 6: Lot 1, 2-4, SW1/4NE1/4, SE1/4NE1/4  
Section 8: E1/2, NW1/4NE1/4, S1/2NW1/4, NW1/4NW1/4  
Section 9: NW1/4

**FOREST SERVICE SPECIAL USE AREAS (all in T 16S R 7 E)**

Sediment Pond Section 5: located within SW1/4SW1/4SE1/4NW1/4  
Topsoil Pile #1 Section 5: located within SE1/4SE1/4SE1/4NW1/4  
Topsoil Pile #2 Section 5: located within SW1/4NW1/4SE1/4NE1/4  
Topsoil Pile #3 Section 4: located within NW1/4NW1/4SE1/4NW1/4  
Topsoil Pile #4 Section 4: located within SW1/4SW1/4NE1/4NW1/4

**SITLA SPECIAL USE LEASE Township 17 South, Range 8 East**

Section 5: located within Lot 6

Total Permit Area 6295.06 acres.

This legal description is for the permit area of the Crandall Canyon Mine. The Permittee is authorized to conduct coal mining and reclamation operations on the foregoing described property subject to the conditions of the leases, the approved mining plan, including all conditions and all other applicable conditions, laws and regulations.

**Sec. 3 COMPLIANCE** - The Permittee will comply with the terms and conditions of the permit, all applicable performance standards and requirements of the State Program.

**Sec. 4 PERMIT TERM** - This permit expires on May 13, 2013.

**Sec. 5 ASSIGNMENT OF PERMIT RIGHTS** - The permit rights may not be transferred, assigned or sold without the approval of the Director, DOGM. Transfer, assignment or sale of permit rights must be done in accordance with applicable regulations, including but not limited to 30 CFR 740.13(e) and R645-303.

**Sec. 6 RIGHT OF ENTRY** - The Permittee shall allow the authorized representative of the DOGM, including but not limited to inspectors, and representatives of OSMRE, without advance notice or a search warrant, upon presentation of appropriate credentials, and without delay to:

- (a) Have the rights of entry provided for in 30 CFR 840.12, R645-400-110, 30 CFR 842.13 and R645-400-220; and,
- (b) Be accompanied by private persons for the purpose of conducting an inspection in accordance with R645-400-100, R645-400-200 and 30 CFR 842, when the inspection is in response to an alleged violation reported by the private person.

**Sec. 7 SCOPE OF OPERATIONS** - The Permittee shall conduct coal mining and reclamation operations only on those lands specifically designated as within the permit area on the maps submitted in the mining and reclamation plan and permit application and approved for the term of the permit and which are subject to the performance bond.

**Sec. 8 ENVIRONMENTAL IMPACTS** - The Permittee shall minimize any adverse impact to the environment or public health and safety through but not limited to:

- (a) Accelerated monitoring to determine the nature and extent of noncompliance and the results of the noncompliance;
- (b) Immediate implementation of measures necessary to comply; and
- (c) Warning, as soon as possible after learning of such noncompliance, any person whose health and safety is in imminent danger due to the noncompliance.

**Sec. 9 DISPOSAL OF POLLUTANTS** - The Permittee shall dispose of solids, sludge, filter backwash or pollutants in the course of treatment or control of waters or emissions to the air in the manner required by the approved Utah State Program and the Federal Lands Program which prevents violation of any applicable state or federal law.

**Sec. 10 CONDUCT OF OPERATIONS** - The Permittee shall conduct its operations:

- (a) In accordance with the terms of the permit to prevent significant, imminent environmental harm to the health and safety of the public; and
- (b) Utilizing methods specified as conditions of the permit by DOGM in approving alternative methods of compliance with the performance standards of the Act, the approved Utah State Program and the Federal Lands Program.

**Sec. 11 EXISTING STRUCTURES** - As applicable, the Permittee will comply with R645-301 and R645-302 for compliance, modification, or abandonment of existing structures.

**Sec. 12 RECLAMATION FEE PAYMENTS** - The operator shall pay all reclamation fees required by 30 CFR Part 870 for coal produced under the permit, for sale, transfer or use.

- Sec. 13 AUTHORIZED AGENT** - The Permittee shall provide the names, addresses and telephone numbers of persons responsible for operations under the permit to whom notices and orders are to be delivered.
- Sec. 14 COMPLIANCE WITH OTHER LAWS** - The Permittee shall comply with the provisions of the Water Pollution Control Act (33 USC 1151 et seq,) and the Clean Air Act (42 USC 7401 et seq), UCA 26-11-1 et seq, and UCA 26-13-1 et seq.
- Sec. 15 PERMIT RENEWAL** - Upon expiration, this permit may be renewed for areas within the boundaries of the existing permit in accordance with the Act, the approved Utah State Program and the Federal Lands Program.
- Sec. 16 CULTURAL RESOURCES** - If during the course of mining operations, previously unidentified cultural resources are discovered, the Permittee shall ensure that the site(s) is not disturbed and shall notify DOGM. DOGM, after coordination with OSMRE, shall inform the Permittee of necessary actions required. The Permittee shall implement the mitigation measures required by DOGM within the time frame specified by DOGM.
- Sec. 17 APPEALS** - The Permittee shall have the right to appeal as provided for under R645-300.
- Sec. 18 SPECIAL CONDITIONS** - There are special conditions associated with this permitting action as described in Attachment A.

The above conditions (Secs. 1-18) are also imposed upon the Permittee's agents and employees. The failure or refusal of any of these persons to comply with these conditions shall be deemed a failure of the Permittee to comply with the terms of this permit and the lease. The Permittee shall require his agents, contractors and subcontractors involved in activities concerning this permit to include these conditions in the contracts between and among them.

These conditions may be revised or amended, in writing, by the mutual consent of DOGM and the Permittee at any time to adjust to changed conditions or to correct an oversight. DOGM may amend these conditions at any time without the consent of the Permittee in order to make them consistent with any new federal or state statutes and any new regulations.

**THE STATE OF UTAH**

By: John R. Bayne  
Date: 11/9/2012

I certify that I have read, understand and accept the requirements of this permit and any special conditions attached.

\_\_\_\_\_  
**Authorized Representative of  
the Permittee**

Date: \_\_\_\_\_

## **Attachment A**

### **SPECIAL CONDITIONS**

1. Genwal Resources, Inc. will submit water quality data for the Crandall Canyon Mine in an electronic format through the Electronic Data Input web site, <http://linux1.ogm.utah.gov/cgi-bin/appx-ogm.cgi>.
2. Prior to the final disposal of the iron sludge in the Burma pond, Genwal Resources, Inc. will need to obtain authorization to do so from the Department of Environmental Quality Division of Solid & Hazardous Waste through the permit by rule process.

# State of Utah



## Coal Regulatory Program

Crandall Canyon Mine  
Genwal Resources, Inc.  
Burma Evaporation Pond Technical Analysis  
November 5, 2012

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## TECHNICAL ANALYSIS DESCRIPTION

Genwal Resources, Inc. has proposed to construct an evaporation basin to aid in the disposal of iron sludge material currently produced at the Crandall Canyon mine site. The project is planned to be built on 7.32 acres of SITLA property located near the mouth of Huntington Canyon in Emery County, Utah in Lot 6, Section 5, Township 17 South, Range 8 East, Salt Lake base meridian.

The Crandall Canyon Mine is currently discharging water that is above the UPDES compliance limit for iron. The company has constructed a water treatment facility at the minesite to reduce the iron concentration to within acceptable discharge levels. The facility utilizes an aeration unit, a chemical injection system to coagulate and flocculate the precipitated iron, and a settling basin to allow the precipitated iron to accumulate. While the treatment facility has provided a means whereby they can legally discharge the mine water, the Company now needs a location for desiccating and disposal of the iron sludge. This evaporation basin will provide the means and location for the disposal of the iron sludge material.

The Burma Evaporation pond is considered to be an installation which facilitates mining and reclamation operations, therefore it requires a permit under the Surface Mining Control and Reclamation Act (SMCRA). Genwal Resources has provided a complete and accurate application for obtaining a permit for the pond. This document is a technical review of the application and documents the finding made with regard to the application being found complete and accurate.

## SUMMARY OF PERMIT CONDITIONS

As determined in the analysis and findings of this Technical Analysis, approval of the plan is subject to the following Permit Conditions. The applicant is subject to compliance with the following Permit Conditions and has committed to comply with the requirements of these conditions as referenced in the approved Permit.

Accordingly, the permittee has committed to comply with the requirements of the following Permit Condition, as specified, and in accordance with the requirements of:

**R645-301-528.332:** Prior to the final disposal of the iron sludge in the Burma pond, Genwal Resources, Inc. will need to obtain authorization to do so from the Department of Environmental Quality Division of Solid & Hazardous Waste through the permit by rule process.

## **GENERAL CONTENTS**

### **VIOLATION INFORMATION**

Regulatory Reference: 30 CFR 773.15(b); 30 CFR 773.23; 30 CFR 778.14; R645-300-132; R645-301-113

#### **Analysis:**

A 510 C check was done through the OSM database. No violations were found.

#### **Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

### **RIGHT OF ENTRY**

Regulatory Reference: 30 CFR 778.15; R645-301-114

#### **Analysis:**

The Applicant has provided a copy of the lease documents that were used to acquire the SITLA lease where the Burma Pond is to be built. Genwal Resources, Inc. has the necessary right of entry to proceed.

#### **Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

### **LEGAL DESCRIPTION AND STATUS OF UNSUITABILITY CLAIMS**

Regulatory Reference: 30 CFR 778.16; 30 CFR 779.12(a); 30 CFR 779.24(a)(b)(c); R645-300-121.120; R645-301-112.800; R645-300-141; R645-301-115.

#### **Analysis:**

There are no unsuitability claims filed on the area proposed for mining operations.

**Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

**PERMIT TERM**

Regulatory References: 30 CFR 778.17; R645-301-116.

**Analysis:**

No change will occur to the permit term as a result of the Burma pond revision. The expiration date of the permit will remain May 13, 2013.

**Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

**PUBLIC NOTICE AND COMMENT**

Regulatory References: 30 CFR 778.21; 30 CFR 773.13; R645-300-120; R645-301-117.200.

**Analysis:**

The Applicant provided opportunity for comment. A notice was placed in the Sun Advocate as well as the Emery County Progress for the four consecutive weeks as required. Publication dates were as follows: February 14, 21, 27 and March 6, 2012

**Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

**PERMIT APPLICATION FORMAT AND CONTENTS**

Regulatory Reference: 30 CFR 777.11; R645-301-120.

**Analysis:**

The application has been formatted in accordance with the R645 regulations

**Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

**COMPLETENESS**

Regulatory Reference: 30 CFR 777.15; R645-301-150.

**Analysis:**

The Division determined the application to be administratively complete on February 1, 2012.

**Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

## **ENVIRONMENTAL RESOURCE INFORMATION**

Regulatory Reference: Pub. L 95-87 Sections 507(b), 508(a), and 516(b); 30 CFR 783., et. al.

### **PERMIT AREA**

Regulatory Requirements: 30 CFR 783.12; R645-301-521.

#### **Analysis:**

An adequate description (meets and bounds) of the Burma Pond area is included in the Application as part of Appendix 1-16 (Special Use Lease Agreement No. 1708).

#### **Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

## **HISTORIC AND ARCHEOLOGICAL RESOURCE INFORMATION**

Regulatory Reference: 30 CFR 783.12; R645-301-411.

#### **Analysis:**

The applicant has provided a report entitled; "An Intensive Cultural Resource Survey and Inventory of the Proposed Iron Evaporation Pond for the Crandall Canyon Mine" produced by Senco-Phenix Archeological consultants. The report covers the area of the Burma pond and concluded that there were no cultural resources at the location and the potential for undetected resources is remote.

#### **Findings:**

A finding of "no effect" to cultural resources is determined.

## **CLIMATOLOGICAL RESOURCE INFORMATION**

Regulatory Reference: 30 CFR 783.18; R645-301-724.

**Analysis:**

The amendment includes climatological factors such as: average monthly temperature, average monthly precipitation, average monthly evaporation, and average monthly wind direction and velocity.

**Finding:**

The requirement for inclusion of climatological resource information is fully met.

**VEGETATION RESOURCE INFORMATION**

Regulatory Reference: 30 CFR 783.19; R645-301-320.

**Analysis:**

The proposed text, "*The Dominant vegetative community over the entire project area is pinyon -juniper. Map 1 of the Vegetation, Wildlife Habitat & sensitive Species report is an aerial photo showing the total area as being chained pinyon -juniper*", is appropriate and has been included in the Vegetation and Wildlife report of the Burma evaporation pond application.

**Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

**FISH AND WILDLIFE RESOURCE INFORMATION**

Regulatory Reference: 30 CFR 784.21; R645-301-322.

**Analysis:**

The proposed text, "*As is discussed on page 12 of the Vegetation, Wildlife Habitat & Sensitive Species report, the entire area (shown on Map 1) is considered crucial winter range for Rocky Mountain elk and Mule deer. The entire study area (shown on Map 1) is considered year-long substantial habitat for Black bear. Finally, the entire area (pinyon-juniper) could be used by Ferruginous hawks because they often nest in this community*", is appropriate and has been included in the Vegetation and Wildlife report of the Burma evaporation pond application.

A map and copy of the May 9<sup>th</sup> raptor survey performed by EIS has been included in Attachment # 15 of Appendix 7-66 of the application.

The mine water consumption calculations (in acre feet per year) for the Crandall Canyon mine has been included in chapter 5, Appendix 7-66 of the application. The calculations for the pond have been provided. The evaporation pond will consume approximately 1.4 acre feet per year resulting in a net gain of the mine water discharge of 642.9 acre feet per year for the mine.

**Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

## **SOILS RESOURCE INFORMATION**

Regulatory Reference: 30 CFR 783.21; 30 CFR 817.22; 30 CFR 817.200(c); 30 CFR 823; R645-301-220; R645-301-411.

**Analysis:**

The 2011 soil survey by Long Resource Consultants is found in Attachment 6 of Appendix 7-66. According to the report, the soils form an alluvial fan on top of a terrace pediment and the alluvium is bisected by shallow ephemeral drainages (p. 1). The site is at an elevation of 6470 ft. with a 3 - 5% slope to the SE. The site is located immediately off of County Rd 333, adjacent to XTO well AP #43 015 30479 in Lot 6, Sec. 5, T. 17 S., R. 8 E. (see Inspection Report #2690).

Pinyon pine and Utah juniper were removed from the area approximately 30 – 40 years ago, but both species have re-established with heights of 6 – 12 feet (p. A-1, Attachment 6) under a climate regime of 13 inches average annual precipitation (p. 1, Attachment 6). Other vegetation present was fourwing saltbush, Salina wildrye, crested wheatgrass, yucca, opuntia, bluegrass, mormon tea, and rabbitbrush, as described in Appendix A of Attachment 6.

The soil uniformly mapped as Strych very stony very fine sandy loam, 3 to 30% slopes. These are deep, well drained soils (p. 4 Attachment 6), not suitable for impounding water. The soil was estimated to have 35 – 67% rock fragments on the surface and 15 – 30% gravels in the profile. The soil is 63 to 85% sand and very fine sand in the surface 30 cm (approximately equal to 12 in.). Even so, the soil colloids retain relatively good amounts of phosphorus and potassium in the surface 30 cm for native plant growth. The surface pH hovers around 7.7 – 8.1, but rises steadily below 30 cm. Surface SAR values are very low, rising to less desirable levels at 120 cm. An average carbonate concentration for the surface 30 cm is 36%. This will translate into cemented soils upon reclamation and it will be imperative that some mulch is used on the interim and final reclamation.

**Findings:**

The information provided meets the requirements of the regulations for soils resource information.

## **LAND-USE RESOURCE INFORMATION**

Regulatory Reference: 30 CFR 783.22; R645-301-411.

### **Analysis:**

Chapter 4, paragraph 3 of appendix 7-66 states that *“There will be no change in the current land use of the area following reclamation. The present land use supports wildlife and livestock grazing, and no change in grazing activity will occur after reclamation”*.

### **Findings:**

The information is adequate to meet the requirements of this section of the regulations.

## **ALLUVIAL VALLEY FLOORS**

Regulatory Reference: 30 CFR 785.19; 30 CFR 822; R645-302-320.

### **Analysis:**

#### **Alluvial Valley Floor Determination**

There are no alluvial valley floors within the proposed Burma Pond area.

### **Findings:**

The information is adequate to meet the requirements of this section of the regulations.

## **PRIME FARMLAND**

Regulatory Reference: 30 CFR 785.16, 823; R645-301-221, -302-270.

### **Analysis:**

Following the protocol required by the National Cooperative Soil Survey, the Order II soil survey documented the site conditions and the dry stony soil which has never been

cultivated. The Permittee has stated in Appendix 7-66 that there is no prime farmland within the proposed SITLA lease for the Burma Pond. The Division has also observed that there is no existing farming or historic farming use along the Burma Road or within the proposed SITLA lease area.

**Findings:**

The information meets the prime farmland requirements of R645-303-313.100.

**HYDROLOGIC RESOURCE INFORMATION**

Regulatory Reference: 30 CFR Sec. 701.5, 784.14; R645-100-200, -301-724.

**Analysis:**

The Permittee conducted a search of the area for available data and no active groundwater wells, springs or other expressions within the search area. Given the engineered liner of the evaporation pond eliminating infiltration and the total containment design eliminating surface discharge no further investigation for baseline data is required.

**Findings:**

The amendment meets the requirements for baseline information.

**Probable Hydrologic Consequences (PHC)**

**Analysis:**

The Permittee included a PHC as Attachment 14 in the revised amendment. The PHC addresses: contamination by sludge materials, increased sediment yield from disturbed areas, increased sediment yield from disturbed areas, increased total dissolved solids concentrations, impacts to groundwater or surface water availability, hydrocarbon contamination from trucks or from the use of hydrocarbons in the permit area, contamination of surface and groundwater from road salting, and contamination of surface water from sludge spillage due to hauling operations.

**Findings:**

The PHC in the revised amendment meets these requirements.

**MAPS, PLANS, AND CROSS SECTIONS OF RESOURCE INFORMATION**

Regulatory Reference: 30 CFR 783.24, 783.25; R645-301-323, -301-411, -301-521, -301-622, -301-722, -301-731.

**Analysis:**

All required maps, plans, and cross sections of the basin are included within the application in Attachment 1 of Appendix 66. Drawings are appropriately certified.

**Findings:**

Contents and information provided are sufficient enough to meet the minimum requirements of this section of the Utah Coal Mining Rules.

**Well Maps**

**Analysis:**

The Permittee has included Figure 7-1 of water rights and conducted a search of available data and found no active groundwater wells, springs or other expressions within the search area.

**Findings:**

The requirement for inclusion of well maps has been met.

**Monitoring and Sampling Location Maps**

**Analysis:**

The Permittee conducted a search of available data and found no active groundwater wells, springs or other expressions within the search area.

**Findings:**

The requirement for inclusion of well maps has been met.

**Surface Water Resource Maps**

**Analysis:**

The Permittee has included Figure 7-1 of water rights and conducted a search of available data and found no active groundwater wells, springs or other expressions within the search area.

**Findings:**

The requirement for surface water maps has been met.

## **OPERATION PLAN**

### **MINING OPERATIONS AND FACILITIES**

Regulatory Reference: 30 CFR 784.2, 784.11; R645-301-231, -301-526, -301-528.

#### **Analysis:**

The application contains a description of the proposed Burma Pond and also describes its intended use.

#### **Findings:**

The information is adequate to meet the requirements of this section of the regulations.

### **EXISTING STRUCTURES:**

Regulatory Reference: 30 CFR 784.12; R645-301-526.

#### **Analysis:**

There are no existing structures to be used with the Burma Pond facility.

#### **Findings:**

The information is adequate to meet the requirements of this section of the regulations.

### **PROTECTION OF PUBLIC PARKS AND HISTORIC PLACES**

Regulatory Reference: 30 CFR 784.17; R645-301-411.

#### **Analysis:**

The last sentence in chapter 4 includes the following statement "*There are no public parks or historic places within the proposed disturbed area*".

#### **Findings:**

The information is adequate to meet the requirements of this section of the regulations.

## **AIR POLLUTION CONTROL PLAN**

Regulatory Reference: 30 CFR 784.26, 817.95; R645-301-244, -301-420.

### **Analysis:**

The application includes a description of the coordination and compliance efforts which have been undertaken by the applicant with the Utah Bureau of Air Quality, (Attachment 16). Emissions from the pond were determined to be insignificant and did not require a modification to the current air quality permit for the mine.

### **Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

## **FISH AND WILDLIFE INFORMATION**

Regulatory Reference: 30 CFR Sec. 784.21, 817.97; R645-301-322, -301-333, -301-342, -301-358.

### **Analysis:**

#### **Protection and Enhancement Plan**

The text in chapter 4 of Appendix 7-66 has been revised to include the following commitment: "UEI will partner with the Division of Wildlife Resources, DWR, in a Utah Partners in Conservation Development, UPCD project, pinyon-juniper treatment for deer and elk crucial winter range, in locations at or near the Burma pond or as designated by DWR. Funding will be provided by UEI for approximately 5.6 acres of habitat improvement based on a cost per acre provided by DWR".

### **Findings:**

The information is adequate to meet the requirements of this section of the regulations.

## **TOPSOIL AND SUBSOIL**

Regulatory Reference: 30 CFR Sec. 817.22; R645-301-230.

**Analysis:**

**Topsoil Removal and Storage**

In Chapter 2 of Appendix 7-66, the Permittee describes removal of topsoil from 1.41 acres of the 7.32 acres permit area. The 1.41 acre area to have topsoil removed will correspond to the access road, the evaporation basin, but not the topsoil storage area. Appendix 7-66 recommends the surface foot of topsoil be salvaged. However, given that the surface is approximately 50% boulders, an average depth of six inches topsoil is expected to be recovered from the topsoil salvage area of 1.41 acres. A total stored topsoil volume of 1,137 cu yds is expected (Chap 2). Drawing #4 of App. 7-66 shows the site layout. The topsoil storage area with dimensions shown on Dwg #4 will cover approximately 0.2 acres, but it will not be cleared of existing topsoil. Boulders will be stored in the outslope of dam embankments and in the southern portion of the 7.32 acre site. Chapter 5 indicates that the area to be disturbed will be flagged. Chapter 5 also describes the construction sequence step by step.

The topsoil storage pile will be low lying and linear (Chap 5, p. 4). The topsoil stockpile may be 40 ft. wide x 170 ft. long x 10 ft. high (Chap 2, App 7-66). The Dwg #5 illustrates a trapezoidal pile with a maximum of 2h:1v slopes. There is plenty of space within the 7.32 acre disturbed area. The potential for a broad pile with gentle slopes will be discussed with the professional soils that will be pre-approved by the Division as discussed in Chapter 2.

The topsoil stockpile will be mulched using 1 Ton/acre straw incorporated into the surface (Chap 2). The topsoil stockpile will be seeded with the mix stated in Attachment 8.

**Findings:**

The information meets the requirements of R645-301-230 Operation Plan for topsoil handling and storage.

**SPOIL AND WASTE MATERIALS**

Regulatory Reference: 30 CFR Sec. 701.5, 784.19, 784.25, 817.71, 817.72, 817.73, 817.74, 817.81, 817.83, 817.84, 817.87, 817.89; R645-100-200, -301-210, -301-211, -301-212, -301-412, -301-512, -301-513, -301-514, -301-521, -301-526, -301-528, -301-535, -301-536, -301-542, -301-553, -301-745, -301-746, -301-747.

**Analysis:**

The sludge being dried in the basin is defined as "noncoal mine waste" as per R645-528.331. As per R645-301-528.332, the permittee is required to ensure that leachate and drainage from the noncoal mine waste area does not degrade surface or underground water, routinely compact and cover to prevent combustion and wind-borne waste, and when the

disposal is completed, a minimum of two feet of soil cover will be placed over the site, slopes, stabilized, and revegetation accomplished.

The text on page 8 of Appendix 7-66 was modified to include the following: "The waste will be routinely compacted and covered to prevent combustion and wind-borne waste."

### **Disposal of Noncoal Mine Waste**

Article 5.3 of the SITLA Lease specifies that no hazardous waste will be brought to the SITLA property and further defines hazardous waste as any regulated toxic substance and PCB's, and petroleum products.

To conform with this requirement, a sampling and monitoring plan for the waste is will be conducted at five year intervals (mid-term) or with every 7.5 inches of waste deposited at the Burma Pond site (Chapter 5, page 2, Item 2). Grab sampling of the Burma Pond waste will occur in accordance with R645-301-536.320 and will be monitored in accordance with 40 CFR 264.13 for RCRA metals. The RCRA analysis is specified in the plan (Chap 5, p 8). The monitoring commitment also states that aluminum, zinc and nickle which may be of agronomic concern, but are not RCRA metals, will also be tested (Chap 5, p. 8).

Appendix 7-65 describes the temporary the mine water treatment facility producing the iron sludge. Attachment 10 of Appendix 7-66 provides an analysis of metals using EPA Method 200.7 and 200.8 on grab samples of the sediment, taken in February 2011 and of the flock (flocculent) taken in April 2010. (Analyses were performed by SGS Labs in Huntington and Horizon Lab in Price.) The concentrations of analytes all fell within the EPA limits for the metals tested. On the two sampling dates, the following metal cations were found in highest concentrations: aluminum (3,260 mg/L), barium (0.825 mg/L), iron (1,110 mg/L), zinc (2.1 mg/L), and nickel (0.428 mg/L). The only metal listed above on the RCRA monitoring list is barium.

The 1976 Resource Conservation and Recovery Act (RCRA) defines hazardous waste by waste stream (F, K, P, or U waste as defined in 40 CFR 261 SubPart D) or by characteristics (40 CFR 261 SubPart C) of ignitability (flashpoint, 140F), corrosivity (pH < 2 or > 12.5), reactivity (with water), and toxicity. The code 40 CFR 261.24 outlines 40 contaminants to be tested by the Toxicity Characteristic Leaching Procedure (TCLP) when defining toxicity. Table 1 of the code lists their maximum allowable concentrations in solid waste. (The allowable limits for the 8 toxic metals listed in Table 1 are as follows:

Arsenic = 5 ppm, (1 ppm is equal to 1 mg/L)

Barium = 100 ppm

Cadmium = 1 ppm

Chromium = 5 ppm

Lead = 5 ppm

Mercury = 0.2 ppm  
Selenium = 1.0 ppm  
Silver = 5 ppm.

**Findings:**

The information provided meets the requirements of the Utah Coal Mining Rules for monitoring acid or toxic forming materials. Contents and information provided are sufficient enough to meet the minimum requirements of this section of the Utah Coal Mining Rules.

**Analysis:**

The Permittee has included the use of the same engineered liner used in their current treatment system to the revised amendment. The Permittee has indicated in the amendment a plan to ultimately bury the dried sludge at the Burma Pond site. This waste has been determined to be noncoal mine waste and must thus meet the standards and permitting for the State of Utah Department of Environmental Quality- Division of Solid and Hazardous Waste (DEQ). Prior to final closure of the Burma Pond site the Permittee must secure a landfill permit from DEQ. The Permittee has included language committing to securing such a permit if waste is to be permanently left buried onsite.

**Findings:**

The information meets the requirements of R645-301-528.332 for final disposal of noncoal mine wastes.

**HYDROLOGIC INFORMATION**

Regulatory Reference: 30 CFR Sec. 773.17, 774.13, 784.14, 784.16, 784.29, 817.41, 817.42, 817.43, 817.45, 817.49, 817.56, 817.57; R645-300-140, -300-141, -300-142, -300-143, -300-144, -300-145, -300-146, -300-147, -300-148, -301-512, -301-514, -301-521, -301-531, -301-532, -301-533, -301-536, -301-542, -301-720, -301-731, -301-732, -301-733, -301-742, -301-743, -301-750, -301-761, -301-764.

**Analysis:**

The basin will consist of a large, shallow evaporation pond, measuring approximately 100' wide by 200' long. It will be constructed about five feet (60") deep, although only the bottom 36" would be utilized for sludge storage/water retention, leaving the top 24" as freeboard.

It is anticipated that cleanout sludge-water from the Crandall water treatment facility will be hauled to the site about 10 eight-hour days (two working weeks) every two months, at two truckloads per day, and 4000 gallons per truckload. This works out to be about 64,200 cu. ft. per year hauled to the site for disposal. The iron cleanout "sludge" material has typically been analyzed at about 50/0 solids and 95% water by weight, and even less by volume, perhaps 2-3%

solids. Therefore, after evaporation of the water, the actual volume of solids left to accumulate in the basin is expected to average about 2400 cu ft. per year. Spread out to dry over the 20,000 square foot bottom of the evaporation basin, the rate of solids accumulation in the basin is expected to be less than 1.5 inches per year or less.

The iron sludge that is meant to be stored in the basin has been tested in the lab for RCRA metals, and has been found to be non-toxic, non-hazardous and non-acid forming (results included in the application within Attachment 10) Also, the chemicals used in the water treatment (coagulant and flocculent) are all NSF-60 certified (results included in the application within Attachment 12)

A stability analysis for the construction of this earthen berm is included in Attachment 11.

**The safety factor for the proposed embankment was calculated at 12.03 for dry conditions and 10.53 for saturated conditions.**

### **Groundwater Monitoring**

#### **Analysis:**

No groundwater monitoring program is included in the revised amendment. However; due to proposed implementation of an engineered liner, groundwater will be fully protected and no monitoring program will be required.

#### **Findings:**

The requirement for evaluation of a groundwater monitoring program has been met.

### **Surface Water Monitoring**

#### **Analysis:**

No surface water monitoring plan is proposed in the application. However, the amendment fully documents that the evaporation pond can achieve full containment. Further the amendment documents that a sediment cleanout marker and a 100 year 24 hour storm event marker will be installed 4.44 inches below the spillway elevation. These markers will be used to field evaluate that full containment is being maintained. Since full containment will be maintained at all times a Utah Pollutant Discharge Elimination System (UPDES) permit will not be required. Last, the use of an engineered liner in the pond rules out the possibility of infiltration.

**Findings:**

The amendment meets the requirements for surface water monitoring.

**State Appropriated Water Rights**

**Analysis:**

The Permittee included as Attachment 13 a water rights summary.

**Findings:**

The amendment meets the requirements for state-appropriated water rights.

**Acid- and Toxic-Forming Materials and Underground Development Waste**

**Analysis:**

The Permittee has conducted testing for toxic forming materials and included results in Attachment 10.

**Findings:**

The application meets the requirements for identifying toxic forming materials.

**Impoundments**

**Analysis:**

The Permittee includes language in the application about an emergency spillway, sediment cleanout markers and containment of the maximum storm event. This information is further included in the appropriate figures.

**Findings:**

The application meets the requirements for impoundments.

**RECLAMATION PLAN**

## **POSTMINING LAND USES**

Regulatory Reference: 30 CFR Sec. 784.15, 784.200, 785.16, 817.133; R645-301-412, -301-413, -301-414, -302-270, -302-271, -302-272, -302-273, -302-274, -302-275.

### **Analysis:**

Chapter 4, paragraph 3 of appendix 7-66 states that *“There will be no change in the current land use of the area following reclamation. The present land use supports wildlife and livestock grazing, and no change in grazing activity will occur after reclamation”*.

### **Findings:**

The information is adequate to meet the requirements of this section of the regulations.

## **BACKFILLING AND GRADING**

Regulatory Reference: 30 CFR Sec. 785.15, 817.102, 817.107; R645-301-234, -301-537, -301-552, -301-553, -302-230, -302-231, -302-232, -302-233.

### **Analysis:**

The applicant states that the dried sludge material will be left in place and buried on-site as part of the final reclamation process. The material would be buried under 48" of inert earthen material during reclamation, top-soiled and re-vegetated.

The application includes details of final reclamation and includes a commitment that the basin will be backfilled and graded to ultimately achieve approximate original contours (AOC).

Cubic yardages for backfilling and grading estimates are included in the application.

The text on page 4 of Appendix 7-66 was modified to include the following:  
“Reclamation of the project area will be according to and along with the approved reclamation time line found in Section 3.41.100 of the approved MRP. In the event that discharged mine water no longer requires treatment and/or the basin is no longer receiving sludge, the reclamation timeline for the Burma basin will be adjusted as follows: Reclamation will begin after three years without receiving sludge, and reclamation will be completed within one year of commencement.”

### **General**

App. 7-66, Chapter 5 describes 2,363 cu yds of subsoil stockpiled in the berm around the pond. This material will cover the 0.5 acre pond area (200ft x 100 ft) to a depth of three feet. Chap. 3 describes replacement of this subsoil in 18 inch lifts over an accumulated layer of dried sludge (estimated to be 24 inches deep after 16 years, Chap. 5). Using the permittee's estimates, of 1.5 inch accumulation per year, the life of this facility is twenty four years, at which time the dried waste will be at the design maximum of 36 inches, leaving 24 inches of freeboard (Chap. 5). (The plan does indicate that there is room for expansion to the east and west within the permitted area.)

In accordance with R645-301-542.742, the plan provides for routine compaction of the waste and covering to prevent windborne waste (Chap. 5, p. 8, Item 7)

Upon final reclamation, the first 18 inch lift of cover soil will be incorporated into the mine waste with ripping or other tillage (Chap 3, Item b). In this manner, the waste will be incorporated into the soil and will not create a chemical or physical barrier to roots, promoting revegetation success, in accordance R645-301-542.730.

**Findings:**

Contents and information provided are sufficient enough to meet the minimum requirements of this section of the Utah Coal Mining Rules.

**TOPSOIL AND SUBSOIL**

Regulatory Reference: 30 CFR Sec. 817.22; R645-301-240.

**Analysis:**

The Burma evaporation pond disturbed area is recorded as 7.32 acres. However the Permittee anticipates soil salvage and redistribution from only 1.41 acres. Redistribution depth of the 1,137 cu yd topsoil will be six inches over the 1.41 acres as described in (Chap. 2).

**Findings:**

The information provided meets the requirements of R-645-301-242, Soil Redistribution.

**HYDROLOGIC INFORMATION**

Regulatory Reference: 30 CFR Sec. 784.14, 784.29, 817.41, 817.42, 817.43, 817.45, 817.49, 817.56, 817.57; R645-301-512, -301-513, -301-514, -301-515, -301-532, -301-533, -301-542, -301-723, -301-724, -301-725, -301-726, -301-728, -301-729, -301-731, -301-733, -301-742, -301-743, -301-750, -301-751, -301-760, -301-761.

## **Hydrologic Reclamation Plan**

### **Analysis:**

As described previously in the noncoal mine waste section of this memo, the Permittee must obtain a permit from the Utah DEQ for operation of a solid waste facility prior to application approval. The Permittee must fulfill all requirements of DEQ for closure. The Permittee has included language for to meet the permitting requirements of DEQ as needed.

### **Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

## **REVEGETATION**

Regulatory Reference: 30 CFR Sec. 785.18, 817.111, 817.113, 817.114, 817.116; R645-301-244, -301-353, -301-354, -301-355, -301-356, -302-280, -302-281, -302-282, -302-283, -302-284.

### **Analysis:**

The application includes a statement that describes how the following requirements will be achieved:

**Revegetation: General Requirements**

**Revegetation: Timing**

**Revegetation: Mulching and Other Soil Stabilizing Practices**

**Revegetation: Standards for Success**

References to the appropriate sections of Volume A of the MRP include section 3.41.100.

### **Findings:**

The information in the application is adequate to meet the requirements of this section of the regulations.

## **STABILIZATION OF SURFACE AREAS**

Regulatory Reference: 30 CFR Sec. 817.95; R645-301-244.

**Analysis:**

Article 10.2 of the SITLA lease (Attachment 2) requires intermediate reclamation of disturbed areas not required for continuing operations, along with control of noxious weeds. Article 12.2 requires reclamation upon termination of the lease and stipulates 4 feet of cover over the iron precipitate and control of noxious weeds.

Chapter 3, Item b describes incorporation of 1 T/ac straw mulch with surface roughening, followed by 1,000 lbs/ac wood fiber mulch and 500 lbs/ac tackfier.

The permitted area is 7.32 acres; however the proposed disturbed area is 1.41 acres. App 7-66 describes interim reclamation on the outslope of the pond containment berm during operations. The plan also references interim reclamation of land which does not have topsoil removed, but which may be affected by equipment moving boulders and topsoil from the pond location to storage locations (Chapter 5, Item 6).

Chapter 5, Page 8, Item 6 also includes a provision for placement of 6 inches of subsoil over the sludge during temporary cessation periods lasting 6 months or longer, to comply with R645-301-542.742, R645-301-244.100 and R645-301-515.321.

**Findings:**

The information provided meets the requirements for stabilization of surface areas R645-301-244.100.

**BONDING AND INSURANCE REQUIREMENTS**

Regulatory Reference: 30 CFR Sec. 800; R645-301-800, et seq.

**Analysis:**

Division records indicate that the Crandall mine currently has surety bond posted in the amount of ~ \$2,327,000.

Updated bond calculation spreadsheets were provided with the response application. Updated costs were provided in terms of Demolition, backfilling & grading, and re-vegetation. Burma basin unit cost estimates were provided as line items for each of the areas listed above. With the Burma basin included (as demolition area #52) the new direct cost subtotals are as follows:

Demolition and Removal      \$772,145.67

Backfilling and Grading	\$552,982.72
Revegetation	\$62,735.00

The total estimated bond after including indirect costs is \$1,759,811.39. This number was correctly escalated 5 years at 1.2% leaving a total mine bond amount of \$1,867,964.39. The difference between bond amount and posted bond is therefore \$54,000.00 or 2.38%. The calculations are correct and the amount of bond posted is determined to be adequate.

**Findings:**

Contents and information provided are sufficient enough to meet the minimum requirements of this section of the Utah Coal Mining Rules.

## **CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT (CHIA)**

Regulatory Reference: 30 CFR Sec. 784.14; R645-301-730.

**Analysis:**

**Findings:**

**GENTRY MOUNTAIN  
CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT (CHIA)**

**For**

**STAR POINT MINE  
C/007/0006**

**SUNNYSIDE COGENERATION ASSOCIATES  
C007/0042**

**HIAWATHA MINES COMPLEX  
C/007/0011**

**DEER CREEK MINE WASTE ROCK STORAGE FACILITY  
C/015/0018**

**TRAIL CANYON MINE  
C/015/0021**

**BEAR CANYON MINE  
C/015/0025**

**CRANDALL CANYON MINE  
C/015/0032**

**in**

**CARBON AND EMERY COUNTIES, UTAH**

**November 6, 2012**

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## I. INTRODUCTION

This CHIA (Cumulative Hydrologic Impact Assessment) predicts potential cumulative impacts to the hydrologic balance, associated with past, present and anticipated coal-mining operations within the Cumulative Impact Area (CIA). The CHIA determines whether material damage effects outside the individual permit boundaries will result from mining activities.

The CHIA document will:

1. Identify the Cumulative Impact Area. (Part II)
2. Describe the hydrologic system and its water resources. (Part III)
3. Predict hydrologic impacts. (Part IV)
4. Assess material damage. (Part V)
5. Make a statement of findings. (Part VI)

This CHIA has been prepared by the Utah Division of Oil, Gas, and Mining (UDOGM or the Division) and complies with Federal and Utah coal regulations 30 CFR 784.14(f) and R645-301-729, respectively. A major revision of the CHIA was completed June 21, 2001: this was for the Bear Canyon Mine-Wildhorse Ridge permit extension. A minor update to the CHIA was completed on September 4, 2003 to define the area and features controlled by Sunnyside Cogeneration Associates (SCA) for the Star Point Refuse operation, and another update was completed on September 24, 2004. This March 2007 update is because of the addition of leases U-46484, U-61048, and U-61049; the remainder of U-024316; and adjacent fee coal lands to the Bear Canyon Mine permit area. These tracts were already included in the CIA boundary.

In addition to the references cited, hydrologic and geological information was obtained from the Mining and Reclamation Plans (MRP) of the Bear Canyon Mine, Star Point Mine, Hiawatha Mine, Trail Canyon Mine and the Deer Creek Mine waste rock storage facility. Previous versions of this CHIA included references to a pre-1966 Star Point Mine Plan: the Star Point Mine Plan was revised in September 1996, and much detailed information from the previous plan was not included in the current mine plan. A copy of this pre-1966 plan is not available for quick reference, although it could be requested from state archives if needed. Information taken from this earlier plan is considered valid, but because the source cannot be checked directly, sections that refer to information from this earlier plan are enclosed in brackets [ ] in this CHIA.

## II. CUMULATIVE IMPACT AREA (CIA)

The Gentry Mountain Cumulative Impact Area (CIA) is located near Price, Utah, within the Transition Province between the Great Basin and Colorado Plateau. The CIA surrounds Gentry Mountain Ridge, which lies south of the town of Scofield in Carbon County and north of Huntington City in Emery County (Map 1). The area of interest can be found on the Hiawatha, Wattis, Candland Mountain, and Huntington U. S. Geological Survey (USGS) 7.5 minute quadrangles.

The CIA is shown in detail on Map 2. This CIA is the region where past, present, and anticipated or foreseeable future coal mining activities may interact to affect surface and ground water. The CIA boundary incorporates mined areas and proposed mine-lease areas at the Star Point, Hiawatha, Trail Canyon, and Bear Canyon Mines and at the Deer Creek refuse pile and the SCA Star Point Refuse operation. The CIA is defined based on the potential for the hydrologic resources to be impacted by mining activities. Potential surface and ground-water impact areas are within the CIA outlined in Map 2.

Surface waters from the CIA flow from the eastern divide of the Wasatch Plateau to either the Price River or the San Rafael River. These rivers then discharge to the Green River before its confluence with the Colorado River.

Ground water from the CIA includes all ground water known to flow through or originate within the CIA boundary and includes all known ground-water<sup>1</sup> discharge points that have the potential to be in hydrologic connection with the mines. Determination of the ground-water CIA boundary has been based on the major geologic features that control flow. Ground waters issue from alluvial and colluvial aquifers, perched aquifers, channel sandstones and other water bearing lithologies, and fault and fracture systems within the CIA.

### MINING HISTORY

#### MINING ACTIVITIES IN THE CIA

Mining in the CIA predates the Surface Mining Coal Reclamation Act (SMCRA). Areas that have been mined within the permitted sites in the CIA are shown on Maps 2, 3 and 4.

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<sup>1</sup> The term "regional aquifer" is frequently used in mine plans in the Wasatch and Book Cliffs Coal Fields in reference to the Blackhawk Formation and adjacent strata. The use of this term in these areas likely originated from hydrologic studies conducted by the U.S. Geological Survey. Although some of these formations contain large volumes of ground water, labeling them regional aquifers is not necessarily congruent with the SMCRA definition of an aquifer, "...a zone, stratum, or group of strata that can store and transmit water in sufficient quantities for a specific use." Many of these saturated strata cannot supply water in sufficient quantities for specific uses. Furthermore, most ground-water sources in these coal fields are internally discontinuous, and although they may be saturated over great areas, they do not effectively transport water on a regional scale. Unless information indicates it is appropriate to identify these saturated strata as aquifers, the Division refers to them simply as saturated strata or ground-water zones.

**Star Point Mine (Plateau Mining Corporation - Permit C/007/006)**

The Wattis, Third (Middle), and Hiawatha Seams have been mined within the Star Point Mine permit area. Early development occurred on the east side of the Bear Canyon Fault (Map 3). Subsequent access to mining in the Gentry Ridge Horst, west of the Bear Canyon Graben, was by a 3-main-entry rock tunnel constructed through the graben in 1989. Coal was removed through the Lion Deck Portal Area.

Operations began in 1916 when the Wattis brothers and Mr. Browning bought 160 acres from the United States and developed the property for coal production. The Lion Coal Company operated the Wattis No.1 and No. 2 Mines until the end of 1963: the Wattis mines have also been known as the Plateau and Star Point mines. Mining was idled from 1964 through 1967 (Doelling, 1972).

United Nuclear Corporation (UNC) acquired the mines in 1971. UNC modernized the mines and expanded the Lions Deck facilities.

After mining operations resumed in 1971, the mines changed names and ownership several times. UNC operated the mines under the name Plateau Mining Company from October 21, 1971 until April 2, 1979, as UNC Plateau Mining Company from April 2, 1979 to July 23, 1980, and again as Plateau Mining Company from July 23, 1980 until August 26, 1982. Plateau Mining Company became Plateau Company, and a new Plateau Mining Company was formed August 26, 1982 to operate the mines. The company name subsequently changed to Cyprus Plateau Mining Company, then Cyprus Plateau Mining Corporation (CPMC). On June 30, 1999, the stock of Cyprus Amax Coal Company was sold to RAG American Coal Company, and CPMC was no longer affiliated with Amax Mineral Company or Amax Energy, Inc. Subsequently, CPMC was merged into RAG American Coal Company. Also on June 30, 1999, the name of the mine operator was changed to Plateau Mining Corporation (PMC), and PMC is the current operator (Star Point Mine Plan, p. 100-2). Because PMC is the current operator of the Star Point Mine and the successor of all previous operators, PMC is identified as the operator throughout this CHIA, no matter what time period is involved.

<b>Table II-1. Star Point Mine Coal Production</b>		
<b>Company</b>	<b>Time Period</b>	<b>Coal Mined (tons)</b>
Lion Coal Company	1917 – 1964	Approximately 7,750,000 *
	1965 - 1966	Idle
Plateau Mining Company	1967 - 1971	750,000
UNC Plateau Mining Company	1971 - 1980	5,000,000
Plateau Mining Company, also d/b/a. Cyprus Plateau Mining Company and Cyprus Plateau Mining Corporation	1980 - 1990	12,000,000
	1991	No information
	1992	2,100,000

	1993	3,000,000
	1994	No information
	1995	No information
	1996	2,900,000 **
	1997	1,350,000 **
	1998	92,000 **
Plateau Mining Corporation	1999	1,055,000 **
	2000	89,000 ** Halted production in March and started reclamation.
	2001	In reclamation
	2002	In reclamation
	2003	In reclamation
	2004	In reclamation
	2005	In reclamation
	2006	In reclamation

\* Doelling 1972; \*\*Jahan Bani, 1997, 1998, 1999, 2000, 2001

PMC began mining from the Star Point No. 1 and No. 2 Mines. They mined in the Hiawatha Third and Wattis seams using room and pillar and longwall methods until the spring of 2000 when they began reclamation operations. Three additional portals were approved for Little Park Canyon but were never built. The Star Point No. 2 Mine's maximum annual coal recovery was approximately 3.5 million raw tons. Currently, PMC has no leasehold interest, options, or pending bids on lands contiguous to the permit area.

The mines were developed through six *portal units*, a unit being an area containing several portals. The Star Point No. 1 and the South Wattis units have been sealed and reclaimed. The two breakouts of the sixth unit, located in a side drainage north and west of the Mudwater Canyon fan unit, were sealed and reclaimed in 1994. A third portal unit at the Star Point No. 2 Mine, located on the Lion Deck, was sealed in January 2001 and reclaimed during 2002. The Corner Canyon fan area, the fourth unit, has three portal entries. The Mudwater Canyon fan unit, the fifth unit, has five portal entries, all of which were sealed and reclaimed in 2000- 2001.

#### **Star Point Refuse (Sunnyside Cogeneration Associates - Permit C007/0042)**

Sunnyside Cogeneration Associates (SCA) will mine the coal refuse pile remaining at the Star Point Mine. SCA acquired the coal refuse and associated subsoil cover material from PMC in January 2002. The State issued the mine permit for surface mining of this material on November 14, 2003. SCA uses the coal refuse as a fuel source in its fluidized-bed combustion boiler at the cogeneration power plant at Sunnyside, Utah.

Construction of the refuse pile began in 1970 with wet processing of "run of mine" coal from the Wattis, Third, and Hiawatha coal seams via the Star Point Mine operations. Refuse was continually added to the pile until mine closure in 2000. The quality of the refuse from the mine changed over time as processing improvements were made. The most deeply buried refuse has greater BTU/lb and is finer than the material above. Approximately 192,000 yd<sup>3</sup> of waste from the Price River Coal AML project (Panther Mine) was transferred to this refuse pile in 1988 (personal communication with MaryAnn Wright, Louis Amodt, and Chris Rohrer of UDOGM, May 15, 2003).

Subsoil salvaged from the expansion of the refuse pile in 1982 will be redistributed over the refuse pile at reclamation. The entire 235,000 yd<sup>3</sup> of salvaged subsoil will be returned to the disturbed area. At final reclamation, 2.7 acres of the refuse pile will receive 4 feet of substitute topsoil cover and 59 acres of the former refuse pile will receive the remainder of the subsoil pile with a minimum coverage of 12 inches, for a total of up to 235,000 yd<sup>3</sup> of substitute topsoil removed from the subsoil stock pile.

Unusable refuse will be permanently placed in the former slurry ponds north of the refuse pile. The discarded refuse will be compacted in lifts of 4 feet into a 4h:1v slope. The refuse samples taken in 1987 had acid-forming potential. The refuse was sampled again in 2001, but not for acid/toxic characteristics. SCA will monitor the refuse placed in the settling basins for acid and toxic characteristics just prior to final reclamation. Accordingly, any toxic waste or waste with the potential for acid-formation or with elevated boron or selenium can be covered with 4 feet of substitute topsoil from the subsoil pile.

**Bear Canyon Mine (C.W. Mining Company, d/b/a Co-Op Mining Company - Permit C015025)**

C.O.P Coal Development Company is the owner or leaseholder of the mineral estate in the Bear Canyon Mine permit area and in a large share of the adjacent area. C.O.P. and the USFS are the main surface estate holders. C.O.P. has subleased all its fee and federal coal rights to C.W. Mining Company, operator of the Bear Canyon Mine.

Mining in Bear Canyon dates back to 1885. Mine operators and owners changed often. C.O.P. acquired fee coal lands and federal coal leases in the Bear Canyon area from Peabody Coal Company in 1980, and mining operations began in 1982. C.O.P. obtained federal coal leases U-020668 and U-38727 from Nevada Electric Investment Company in 1992. C.O.P. obtained federal coal leases U-024316 (issued 05/01/1958), U-61049 (issued 11/01/1949), U-46484 (issued 05/01/1958), and U-61048 (issued 02/08/1923) from IPA in 1996. The Wild Horse Ridge extension to the mine was permitted in 2002. . In 2007, approximately 3,800 acres from the four IPA leases and 3,800 acres of C.O.P. fee coal lands were added to the Bear Canyon Mine permit. Altogether, the Bear Canyon Mine permit area covers approximately 11,000 acres.

There are four coal seams at the Bear Canyon Mine; from highest to lowest - the Tank, Upper Bear, Blind Canyon, and Hiawatha Seams. No mining has occurred in the Upper Bear

Seam, and none is planned.

Co-Op started mining the Blind Canyon Seam in Bear Canyon in 1983. Mining was conducted by room and pillar mining methods. Construction of two new portals in the summer of 1986 provided access to the underlying Hiawatha Seam, but with time a rock tunnel from the Blind Canyon Seam became the main access to the Hiawatha Seam, and the Hiawatha working were considered part of the #1 Mine. Production began in the Hiawatha Seam in 1987 but was limited because the coal was scoured by channel-sand formations.

First mining from the Blind Canyon seam occurred from 1983 through 1996. A large channel sandstone that traverses east and west across the Blind Canyon Seam stopped the operator from advancing the mine working to the north after 1993. Further mining in the Blind Canyon Seam is still a possibility in the McCadden Hollow area, on the north side of the channel sandstone. The Bear Canyon Mine Plan indicates this McCadden coal will be accessed by rock slope tunnels from Hiawatha Seam workings, east of the Bear Canyon Fault. Possible advantages of accessing this coal from currently unleased federal coal lands directly to the north have been discussed. Further exploration drilling may indicate faulting and fracturing preclude mining in this McCadden Hollow area, part of which lies in the "Shattered Zone" mapped by Brown (1987).

Co-Op constructed an access road to the Tank Seam, located above the Blind Canyon seam, in 1994. The #2 Mine in the Tank Seam began operations in 1995. By 2001, Co-Op was retreat mining the Blind Canyon and Tank Seams in the #1 and #2 Mines. In 2003 - 2004 the portals were sealed, but not all were backfilled and reclaimed at that time. The #2 Mine pad and access road have been reclaimed, but the #1 pad and access road remain as part of the tippel and loadout operations area.

The Bear Canyon Fault separates the #1 and #2 Mines from the #3 and #4 Mines. The portals for the #3 and #4 Mines, which access the Blind Canyon and Tank Seams respectively, are located in an unnamed side canyon that joins Bear Canyon from the east. Up to six portals are anticipated for these mines, including a portal in Cedar Creek Canyon, near the old King #2 (Mohrland) Mine portal but on the opposite side of the canyon.

The Tank Seam does not crop out in the Wild Horse Ridge area, and initial access to the Tank Seam in the #4 Mine was through a rock tunnel from the #3 Mine. Portals for the #4 Mine were constructed by breakout once a location with suitable conditions was identified near the head of the canyon. A longwall system was purchased in 2006 for use in Mine #4.

Co-Op plans to mine the Blind Canyon Seam under Wild Horse Ridge, but this seam splits and becomes too thin to mine to the north. The Hiawatha Seam is not thick enough to mine under Wild Horse Ridge; however, the Hiawatha will be mined to the north, where it is thicker because one of the splits of the Blind Canyon Seam merges with it. The Hiawatha Seam will be accessed by the proposed portal in Cedar Creek Canyon and possibly through rock tunnels from the #3 Mine. Room-and-pillar mining is planned in the Blind Canyon Seam, but

longwall mining will be used in the Tank and Hiawatha Seams.

Annual production from Co-Op prior to 1996 was 400,000 to 500,000 tons per year. The #3 Mine produced 304,000 tons and the #4 Mine produced 151,000 tons of coal in 2005. Co-Op controls more than 30 million tons of coal reserves (Jahan Bani 2003), and recoverable Reserves are estimated at 15.8 million tons (Bear Canyon Mine Plan, Table 5-1). With the addition of longwall mining and the proposed expansion of the existing loadout in Bear Canyon, production could reach 2.5 million tons/year.

<b>Table II-2. Bear Canyon Mine Coal Production</b>		
Mines	Time Period	Coal Mined (tons)
Blind Canyon Seam workings	1938 - 1957	150,000 total (Section 411.200, Bear Canyon Mine Plan)
#1 and #2	1982 -1996	400,000 to 500,000 annually*
	1996	581,000*
	1997	570,000*
	1998	660,000*
	1999	881,000*
	2000	1,040,000*
	2001	1,254,000**
#1 and #3	2002	957,000**
	2003	713,000**
#3 and #4	2004	339,000**
	2005	455,000**
	2006	800,000 est.**

\* Jahan Bani, 1997, 1998, 1999, 2000, and 2003

\*\* UGS

#### **Hiawatha Mine (Hiawatha Coal Company, Inc. - Permit C/007/011)**

The Hiawatha permit area spans a total of 12,707 acres with 290 acres of disturbed area. The Hiawatha Mines Complex is a consolidation of the King, Hiawatha, Blackhawk, and Mohrland Coal mines that began operating in the early 1900's. United States Fuel Company (U. S. Fuel) began coal-mining operations in 1916 when it took over the properties of the Consolidation Fuel Company: all these properties are within the current permit boundary. U.S. Fuel ceased production in April 1993. Total production thru 1993 was greater than 50 million tons from more than 80 years of mining. The portals are sealed and the refuse pile is being reclaimed.

U.S. Fuel was a subsidiary of Arava Natural Resource Company, Inc. (ANR), which still owns the fee lands and holds the federal coal leases in the Hiawatha permit area. ANR has

leased the coal rights to C.W. Mining Company for inclusion in the Bear Canyon LMU. All U.S. Fuel permits for the Hiawatha Mines Complex were assigned to the Hiawatha Coal Company, Inc. (HCCI) effective December 12, 1997, and HCCI holds the rights to mine all fee and federal coal under the direction of C.W. Mining Company (Section 112.300, Hiawatha Mine Plan).

Portals were constructed for the Hiawatha #1 Mine in 1903. Use of many mining related surface facilities continued post SMCRA within areas identified in Table II-2 (refer to Maps 3 and 6 for general locations). Several portals were associated with pre-SMCRA mining. From 1948 to 1975 the portals at the South Fork Mine yard supported the King No. 1 and King No. 3 Mines, which are interconnected underground. Three prospect portals were developed in the B seam during that time. The three portals of the King No. 5 Mine and the four portals of the adjacent King No. 4 Mine were on the south side of the Middle Fork Mine Yard.

The King No. 6 Mine, located in South Fork Canyon, was developed following the enactment of SMCRA. In 1981, the old portals from the King No. 3 Mine were updated and the King No. 6 haulage portal was developed. One intake airway portal was developed in the North Fork Drainage in 1979. Production from the Hiawatha Complex during the final years of operation, as reported to MSHA, was 584,000 tons in 1990, 197,000 tons in 1991, 108,000 tons in 1992, and 13,500 tons in 1993. The portals of the King No. 4 and King No. 5 Mines were backfilled in the first half of 1993. Plate 3c shows the areas U.S. Fuel Company mined during the last period of mine development. U.S. Fuel Company had plans to mine both the A and B coal seams. They were mining in the B coal seam until 1992, and then began a small amount of mining and exploration in the Hiawatha coal seam.

<b>Table II-3</b>					
<b>Coal Seams at Mines on Gentry Mountain (possible correlation)</b>					
Bear Canyon Mine		Hiawatha Mine Complex		Star Point Mine	
Tank	Mined	Upper seam	Unmined		
Upper Bear	Unmined	B seam (Bear Canyon)	Mined	Wattis	Mined
Blind Canyon	Mined	A seam (split from Hiawatha)	Mined	Third	Mined
Hiawatha	Mined	Hiawatha	Mined	Hiawatha	Mined

<b>Table II-4</b>					
<b>Mine status at Hiawatha Mine Complex</b>					
Mines	Seam	Location of Portal	Working status	Other openings	Reference in Hiawatha Mine Plan
King #1 Mine (Blackhawk)	Hiawatha	Canyon south of Hiawatha	Abandon 1975		Plate 5-2C

Mine)					
King #2 Mine (Mohrland Mine),	Hiawatha	Cedar Canyon	Abandon 1953		Exhibit V-1
King #3 Mine	Hiawatha	Middle Fork of Miller Canyon	Abandon 1948		Plate 5-2C
King #4 Mine	B Seam/ Bear Canyon	Middle Fork of Miller Creek (north side)	Inactive since 1993, considered for future mining	(Vent Portal in Right Fork of Miller Creek)	Plate 5-2A
King #5 Mine	B Seam/ Bear Canyon	Middle Fork of Miller Creek (south side)(	Inactive since 1993, considered for future mining	Break out in left fork of Miller Creek, south side	Plate 5-2A
King #6 Mine	Hiawatha Seam, Bear Canyon/B Seam, Blind/A Seam	Left Fork of Miller Canyon	Inactive since 1993, considered for future mining		Plates 5-2A, B and C.
Hiawatha #1 Mine	Hiawatha Seam	Middle Fork of Miller Creek (south side),	Abandon 1926		Plate 5-2C
Hiawatha #2 Mine	Hiawatha Seam	Middle Fork of Miller Creek (north side)	Abandon 1926	(Vent portal in Right Fork of Miller Creek	Plate 5-2C

Also, see Exhibit IV-5 of the Hiawatha Mine Plan

### **Trail Canyon Mine (Co-Op Mining Company – C/015/021)**

The Trail Canyon Mine is a reclaimed underground mine located in Trail Canyon, a tributary to Huntington Creek (Map 3). This mine operated intermittently beginning in 1921, and was operated by Co-Op Mining Company through 1981. The permit area was approximately 270 acres with 10 acres of disturbed area. Reclamation activities began in June 1987. Most of the site grading and seeding was done in 1988 and 1989, but additional seeding was done as late as 1997. The Trail Canyon Mine obtained Phase I Bond release in July 18, 1994 and Phase II Bond release in January 31, 1996. Phase III Bond release was obtained in January 2001.

### **Deer Creek Waste Rock Storage Facility (PacifiCorp – C/015/018)**

The Deer Creek Waste Rock Storage Facility encompasses 46.22 acres and is located approximately 2 miles northeast of the Deer Creek Mine (Map 6). It is included in the Deer Creek Mine permit. The expected life of the facility is 40 years. This site was predicted to receive 31,200 yd<sup>3</sup> of waste material annually. Rocky Mountain Power, formerly known as Utah Power and Light Company, is the landowner of the Waste Rock Facility area.

### **Burma Evaporation Basin/Landfill (Utah American Energy – C/015/032)**

The Burma evaporation basin/landfill site is located on a 7.32 acre parcel of State of Utah School and Institutional Trust Lands Administration (SITLA) land within Lot 6, Section 5, T17S, R8E, SLBM (Map 6). Construction and operation of the site is authorized under special Use Lease 1708 issued by SITLA on January 5, 2011. The basin is included in the Crandall Canyon Mine permit as Appendix 7-66. The lined evaporation basin is for drying, storage, and land filling of sludge generated by the Crandall Canyon mine water treatment facility. No UPDES outfall is associated with the facility as it has been designed for total containment of the impacted area surface water and precipitation. In addition, due to the presences of a liner no liquids will be discharged to the subsurface. The facility has a design capacity of 16 years at which time the dried sludge be cleaned out and taken for disposal or the site will be closed as a landfill under a Division of Environmental Quality permit.

### III. HYDROLOGIC SYSTEM

The climate and geology, which affect the hydrologic characteristics, are described under specific headings and are followed by sections that discuss the ground water and surface-water resources.

#### CLIMATE

Precipitation stations surrounding the CIA include the Bear Canyon Mine, East Mountain, Skyline Mine, and the town of Hiawatha. Climatic variations at these sites are influenced by elevation and aspect. The Bear Canyon Mine lies at an elevation of approximately 7,400 feet, while the town of Hiawatha lies at an elevation of 7,200 feet. The elevation across the CIA ranges from 6,300 feet at Huntington Creek to 9,850 feet on Gentry Mountain.

The climate of the CIA is semiarid, but precipitation increases with altitude. The average annual precipitation, snow and rain, in the CIA may vary between 10 inches in the valley to over 30 inches on the ridges. In the Wasatch Plateau, about 70 percent of the precipitation falls during October through April, mostly as snow. The direction from which storms approach and characteristics of individual storms strongly influence local climate. Summer thunderstorms and rain showers occur in the mountains and high valleys, but the towns and cities in the valleys may remain dry. Summer thunderstorms are generally localized, high-intensity, short-duration events. The 100-yr 24-hour precipitation event, with a probability of occurrence in any year of 0.01, would vary from 2.8 to 3.4 inches for May through October within the CIA (Miller, 1973).

To illustrate the variation in recorded precipitation, selected data from the Bear Canyon and Trail Canyon Mine rain gauges are presented in Table III-1. The difference in the maximum annual and minimum annual precipitation is considerable for the Bear Canyon and Trail Canyon drainages, which are slightly over a mile apart. The National Resource Conservation Service (NRCS) has two precipitation stations at higher elevations west of the Bear Canyon Mine: from 1961 to 1990 (NRCS, 1994), average annual precipitation was 29 inches at the Mammoth-Cottonwood station (elevation 8,800 feet) and 33 inches at Red Pine Ridge (elevation 9,200 feet).

The evaporation and infiltration rates in the CIA vary according to vegetation, soil type, and time of year. The potential evaporation for Bear Canyon Mine is about 40 inches/year while transpiration is less than 18 inches/year. The relative humidity ranges from 45 percent in the summer to 85 percent in the winter (Bear Canyon Mine Plan).

Weather conditions found in the CIA can be gauged by the Palmer Hydrologic Drought Index (PHDI). This index characterizes dry and moist climate periods for a region. It indicates the severity of a wet or dry spell, with negative values denoting a dry spell, and positive values denoting a wet spell. The CIA borders the southern portion of Region 5 and northern portions of Regions 4 and 7 (Map 1a). Figure 14 illustrates the PHDI in those three regions from 1978 to 2006.

<b>Table III-1 Recorded Precipitation Data</b>					
Mine	Monthly Precipitation (inches)		Annual Precipitation (inches)		
	Max	Min	Max	Min	Avg
Bear Canyon (1993-1996)	3.87 (8/95)	0.07 (6/94)	14.37 (1995)	7.9 (1994)	10.0
Bear Canyon (1999-2002)	3.92 (10/00)	0 (Several months each year)	13.04 (2000)	6.09 (2001)	8.55
Trail Canyon (1993-1996)	5.01 (8/95)	0.15 (6/93)	22.54 (1995)	11.23 (1993)	14.8

Temperatures are seasonally variable and generally cooler at higher elevations. January mean temperatures vary from a mean minimum of 8 to 12°F to a mean maximum of 28 to 32°F. July temperatures vary from a mean minimum of 40 to 52°F to a mean maximum of 72 to 84 °F. The average annual temperature is 45°F (Jeppson and others, 1968).

## **GEOLOGY**

### **GENERAL**

Geology described in this section focuses on elements needed to understand the hydrogeology: stratigraphy, general lithology, structure, and other geologic factors determining occurrence of water.

The principal geologic controls that affect the presence of ground water in the Gentry Mountain area are:

- Stratigraphy and lithology,
- Aquitards,
- Channel sandstones,
- Extensional or boundary faults and grabens,
- Local faults and fissures, and
- Structural dip..

### **STRATIGRAPHY AND GENERAL LITHOLOGY**

Lithology of the Wasatch Plateau consists of Upper Cretaceous and Tertiary strata. Transgressive and regressive phases deposited a number of broad delta and prodelta sheet sandstones along a north-south trending interior seaway. The major coal deposits in Utah were formed along seaway shorelines and are planar and continuous. Landward influences such as small channel splays and levee deposits have created splits in the coal. Tidal inlet deltas, lagoonal muds, and washover fans produced rolls or undulations in the coal formation, fluvial channel scour, and discontinuous lenticular geology.

In ascending order by age, the strata found in the CIA are the Masuk Shale Member of the Mancos Shale, the Star Point Sandstone, the coal bearing Blackhawk Formation, the Castlegate Sandstone, the Price River Formation, the North Horn Formation, the Flagstaff Formation and Quaternary Alluvium (Map 5), and the combined Price River/North Horn Formation. Additional information for these formations can be found in the mine plans and standard geologic references. The Blackhawk Formation and Star Point Sandstone are described in more detail because of their importance to coal mining and hydrology in the CIA.

### **Blackhawk Formation and Star Point Sandstone**

The Star Point Sandstone consists of several sheet sandstones that were deposited along the shores and deltas of a north-south trending interior seaway. In the vicinity of the CIA, the Star Point Sandstone is comprised of, in ascending order, the Panther, Storrs, and Spring Canyon Sandstone Members. These members inter-tongue with marine shale layers of the Mancos Shale. The sandstones are usually gradational and sorted; medium-grained; and cross-bedded at the top and fine-grained to silty at their base. They thicken westward and in places, such as near the central part of Huntington Canyon where they are more than 600 feet thick (Spieker, 1931), they merge into one massive sandstone unit. Farther west they grade into the back-barrier, coastal plain, and deltaic deposits of the Blackhawk Formation.

The Blackhawk Formation, the primary coal-bearing formation in the Book Cliffs and Wasatch Plateau Coal Fields, overlies the Star Point Sandstone. The Blackhawk is roughly 900 to 1,400 feet thick, with mineable coal seams in the lower 400 feet (Doelling, 1972).It

The Aberdeen, Kenilworth, and Sunnyside are sandstone members of the lower Blackhawk Formation and are similar to the sandstone members of the Star Point Sandstone. They are interbedded with coals, shales, and siltstones in the Blackhawk Formation and inter-tongue with the Mancos Shale on the seaway side.

Sandstones in the lower Blackhawk are dominantly sheet deposits, but there are also lenticular channel sandstones that were deposited by fluvial systems. In the upper Blackhawk Formation, sheet sandstones are thinner and less common, but channel deposits are more abundant and are the dominant sandstone bodies. The fluvial channel sandstones are generally fine grained and well cemented. Localized zones of high clay content occur within the channel sandstones. These sinuous channel deposits may be interconnected, but in cross-section or outcrop they appear laterally discontinuous, and hydrologically they act as local, perched aquifers rather than as large saturated zones 1.

The Hiawatha Seam is the lowest mineable coal seam of the Blackhawk Formation. It lies just above, and in places directly on, the Spring Canyon Sandstone. The names and general thicknesses of the mined coal horizons at the various mines are shown below.

#### **Star Point Mine (Star Point Mine Plan)**

Wattis	2 - 12 ft thick; 20 to 90 ft above Third.
Third	3 - 13 ft thick; 30 to 80 ft above Hiawatha.
Hiawatha	1 - 11 ft thick.

Tank 0 - 7 ft thick; uneconomical for development.

**Hiawatha Mine (Hiawatha Mine Plan Information Sheet)**

Upper Seam < 6 ft thick; 300 ft above the B Seam.  
B seam 4- 12 ft thick; 0 -70 ft above A seam.  
A seam 0-12 ft thick; lies 0-60 ft above the Hiawatha.  
Hiawatha up to 24 ft thick.

**Trail Canyon Mine (Limited information in the Trail Canyon Mine Plan)**

Upper Seam No information  
Hiawatha Mined by Community Mine and other predecessors of Trail Canyon Mine in Trail Canyon - no information.

**Bear Canyon Mine (Bear Canyon Mine Plan)**

Tank 0 to 9 ft thick; up to 1,600 ft of overburden; 230 to 340 ft above the Blind Canyon.  
Bear Canyon 0 to 7 ft thick; up to 1,700 ft of overburden; 0 to 100 ft above the Blind Canyon; merges with Blind Canyon.  
Blind Canyon 0 to 18 ft thick; up to 1,800 ft of overburden; up to 110 feet above the Hiawatha; splits to the northeast and merges with the Bear Canyon and Hiawatha.  
Hiawatha 0 to 21 ft thick; interrupted by large sandstone channels; up to 1,900 ft of overburden.

**Aquitards**

The presence of numerous springs in the headwaters of the CIA (Map 6) is a result of impermeable layers within the Blackhawk and overlying formations. Except where fractures are actually opened by tension, shales and siltstones in the formations hinder the vertical movement of ground water. These aquitards contribute to the formation of perched aquifer systems and also limit vertical migration between the sandstone tongues of the Star Point Sandstone (Bear Canyon Mine Plan).

**Channel Sandstones**

Channel sandstones may be isolated and localized, or they may be interconnected. They are commonly enveloped in finer grained sediments in strata overlying the coal seams, but also are found in the roof of the coal seams or even within the coal seams, as at the Bear Canyon Mine. They are a common source of water in the mines. Typically, when water is entering a mine from the surrounding rock, drilling roof-bolt holes into overlying channel sandstones will increase the inflow. Such roof-bolt holes flow until the overlying sandstones are de-watered, usually only a short period of time.

A large channel sandstone in the Blind Canyon Seam has been the major source of water at the Bear Canyon Mine. This channel sandstone traverses east and west across the north end of the Blind Canyon Seam in the No. 1 Mine. Drips from the roof of the mine increased as mining

approached this channel-sandstone unit. Initial flows from this channel sandstone were 120 gpm (Figure 6). Flow rose to over 400 gpm in 1992, then decreased to less than 100 gpm by the time the nearest monitoring point, SBC-9, was abandoned in 1999. Flow monitored at SBC-13 is believed to have originated from the Blind Canyon channel sandstone and flowed through gob to the monitoring point. Drainage in the mine is toward the Hiawatha portals; the water piped through the seals and monitored at SBC-9A.

Farther north, a channel sandstone system traverses the Hiawatha Mine (Plates 5-2a, -2b, and -2c, Hiawatha Mine Plan). Water from these sandstones drains to the Mohrland portal.

## STRUCTURE

[The following discussion includes information from the Star Point Mine Plan as it was prior to the major revision done in 1996. Although there is no reason to consider this information invalid, a copy of that older plan was not available to UDOGM to allow confirmation of the information and UDOGM did not find similar information in the current Star Point Mine Plan. This pre-1966 information is set off with brackets.]

Spieker's 1931 geologic report portrays the major faults, grabens and stratigraphy on Gentry Mountain. Five significant fault zones trend north and south within the CIA; 1) the Pleasant Valley Fault, 2) the Trail Canyon Fault (East Fault of the Pleasant Valley Graben), 3) the Dry Canyon Fault, 4) the Blind Canyon Fault, and 5) the Bear Canyon Fault (Maps 4 and 5). Normal faults trend almost exclusively north-south, forming a series of horsts and grabens that influence the local and regional hydrology. Fault displacements range from several feet to approximately 800 feet. Regional dip is modified locally by the tilt and rotation of individual fault blocks and by broad, gently undulating folds, but large amplitude folds do not occur on the Wasatch Plateau. Faults have also been mapped east of the Bear Canyon Fault in the Star Point Mine area (Maps 3 and 5).

### **Extensional or Boundary Faults and Grabens**

Boundary faults and interior faults of grabens generally form hydrologic boundaries that impede movement of ground water across the faults. A boundary fault is commonly associated with gouge (pulverized clay-like material formed by the grinding of rock as the fault develops) and a highly fractured breccia zone (angular fragments from the fault movement): the amount of gouge and breccia is generally proportional to the amount of movement of the fault. Gouge can impede flow across or along the fault zone and cement the breccia. Fault gouge along the Blind Canyon Fault within the Bear Canyon Mine, in the southeastern zone of the Bear Canyon Graben, was observed to be dry. (Transcripts of Informal Conference, February 28, 1997).

Significant ground water was intercepted in the Star Point Mine at two locations along the east side of the Bear Canyon Fault, the eastern boundary fault of the Bear Canyon Graben. At the 2<sup>nd</sup> Left location in the Star Point Mine, flow at the face from the roof was approximately 6 gpm when mining initially intercepted the fault zone. Within three weeks, liquefied gouge had flowed 10 to 15 ft into two entries. Drill holes at the face penetrated 40 to 60 feet of gouge and fractured rock before tapping a "significant ground water conduit". Flow from the drill holes peaked at

150 gpm, dropped to 50 gpm after two weeks, to 10 gpm after 10 weeks, and finally to no discharge. In the 2<sup>nd</sup> West mains of the Star Point Mine, initial inflow from roof strata was about 20 gpm and decreased to 10 gpm after 4 weeks. Little water flowed from the face. The rapid drops in flow indicate a regional source or aquifer was not intercepted on either side of the fault (Star Point Mine Plan, p. 700-11).

At the Hiawatha Mine, a sustained 900- to 1,000-gpm inflow occurred through the floor where the workings contacted the Bear Canyon Fault in the 10<sup>th</sup> West Section of the U.S. Fuels King IV Mine. The mine did not penetrate the fault or the gouge zone, so the water most likely originates on the east side of the fault. This flow, encountered in the 1970's, diminished significantly within a short time and was flowing approximately 100 gpm when the area was last accessible (Hiawatha Mine Plan, p. 7-10; Star Point Mine Plan, p. 700-11 and -12). The sustained flow from this location indicates the 10<sup>th</sup> West Section breached a larger ground-water system; the mine was probably below the potentiometric surface of the Star Point Sandstone at this location and the water was welling up from underlying Spring Canyon Member.

[Most faults from the extensional system encountered in the Star Point No. 2 Mine had accompanying inflows of ground water where ground water was trapped against a gouge zone and was conducted along the breccia zone of the fault

Water may be conveyed along a fault until, 1) water discharges as a spring, 2) water discharges to a lower perched aquifer system, or 3) water discharges to a more extensive aquifer or ground-water system. . Most springs on Gentry Mountain that have flows in excess of 10 gpm lie either: 1) directly along a fault, 2) in close proximity to a fault, or 3) appear to fall in line with the projection of an identified fault. Higher yielding springs appear to be associated with the north-south extensional fault or joint systems found in the area, and no major springs are associated with east-west oriented compressive fractures (Star Point Mine Plan, p. 700-3).

#### *Pleasant Valley Graben*

The Pleasant Valley Graben extends from Scofield Reservoir south to Huntington Canyon and displaces strata as much as 400 feet near the Star Point Mine. The Pleasant Valley Fault appears continuous from Scofield Reservoir to Meetinghouse Canyon (Map 5). The Trail Canyon Fault, the eastern boundary of the Pleasant Valley Graben, lies along the western edge of the Star Point Mine, where several small faults have been mapped in the boundary fault complex.

The small faults of the east boundary fault complex are en-echelon, to the west, and extend generally south, from the NE/4, Section 15 to the NW/4 of Section 26, T. 15 S., R. 7 E. (Map 5; Star Point Mine Plan, Map 624.110a).

#### *Bear Canyon Graben*

The Bear Canyon Graben forms an irregularly inclined and irregularly bounded trough that extends from south of Huntington Canyon, where it has merged with the Pleasant Valley Graben, northward to First Water Canyon. This graben trends N 4° W, and ranges in width from 1,600 feet to 2,400 feet between the Bear Canyon Fault on the east and the Blind Canyon and Dry

Canyon Faults on the west. The Gentry Ridge Horst lies between the Bear Canyon and Pleasant Valley Grabens in the area north of Tie Fork Canyon (Map 3). The Blind Canyon and Dry Canyon Faults have not been mapped north of the area where the Pleasant Valley and Bear Canyon Grabens merge, south of the Gentry Ridge Horst. This merger zone is also where Brown (1987) mapped a "Shattered Zone" between the Bear Canyon and Dry Canyon Faults.

A great deal of information was collected on the Bear Canyon Graben when developing the Graben Tunnels in the Star Point Mine (Map 3a). These rock tunnels cross the Bear Canyon Graben and connect the Wattis Seam east of the Bear Canyon Fault to the Wattis Seam in the Gentry Ridge Horst. Displacements across the eastern and western most faults averaged 250 feet. Fault gouge zones on the east side of the boundary faults were about 10-20 feet wide and appeared impermeable.

### **Joints and Non-normal Faults**

Joint densities increase near some fault planes, both as part of and in addition to the breccia zone. Joint densities within the Bear Canyon Graben are approximately 50 percent greater than on either side of the graben. Every fault examined at the Star Point Mine contained a gouge zone, but not all had associated zones of breccia or increased joint density (Star Point Mine Plan, p. 700-7 and -8).

According to the pre-1996 Star Point Mine Plan, two types of regional stress occurred in the CIA, resulting in several joint sets. One stress was compressional and the other was extensional. Three orientations of joint sets resulted from each regional stress.

The joints formed during compressional stress are oriented N 58° E, N 58° W, and N 85° W. The N 58° E and N 58° W orientations are vertical, generally planar, and closed with a tendency to terminate over short distances or at lithologic boundaries. Carbonate and pyritic mineralization is common along these joint faces. The N 85° W joints are parallel to the maximum compressive stress.

The joints formed during extensional stress orient N 5° W, N 6° E, and N 14° E. The N 6° E joints are more prominent and open. Due to the open nature of this joint set, ground- and surface-water migration and concentration is common along fracture systems having this orientation.

Two non-normal N 80° W trending faults were encountered in the Star Point No. 2 Mine. Both were filled with biotite-rich intrusive rock at several locations. Displacements along the faults were from 0 to 5 ft within the Star Point Mine.]

A system of joint and fracture sets oriented N 15° E to N 17° E and a second set of minor joints with orientations N 60° E are found in the southern end of the Bear Canyon Graben, near the Bear Canyon Mine (Transcripts of Informal Conference, February 28, 1997).

UDOGM personnel did field work at Birch Spring in October 1998. The goal was: examine the 3-dimensional orientation, continuity, and interconnectivity of fractures associated

with Birch Spring; examine the relationship of the Blind Canyon Fault to Birch Spring and associated fractures; and examine possible relationships between Birch Spring and the geology and geography of the terrain immediately surrounding the spring. Birch Spring is located in an alcove eroded into the Panther Member of the Star Point Sandstone. Birch Spring is not a single source but several sources flowing from fractures and a fault, mainly on the west side of the alcove. The alcove is centered on a highly fractured zone about 20 feet wide. Previous geologic work has identified a broad fracture zone associated with the Blind Canyon Fault: Birch Spring is on a small fault in this zone, and the fault may connect with Blind Canyon Fault (Map 4).

The Blind Canyon fault is evident on aerial photos and on the ground: the fault in the alcove is not the Blind Canyon fault. Most of the area is jointed, the distance between joints ranging from 2 or 3 feet to 35 feet; one section between the Blind Canyon fault and Birch Spring is not visibly jointed across an exposure approximately 50 feet wide. Joints and faults appear to strike consistently N-S  $\pm 5^{\circ}$ , but a few joints strike approximately N 20<sup>o</sup>W. Joints and faults appear to be vertical and planar, but on large vertical exposures, the joints are often seen to be gently curved or even sinuous. Observed faults are characterized by zones, several feet wide, of large, blocky rubble or breccia: fracturing in the zone is dominantly vertical to near vertical. Faults and large joints seen in the Panther Sandstone can be projected across the overlying shales (even though the fractures are often not evident in the shales) and into the Storrs Sandstone. Some large, adjacent joints are connected by sets of steeply dipping fractures, similar to the zones at the faults only not vertically extensive and not as brecciated. Large fractures can be followed or projected for hundreds of feet along strike. The fractures appear to be gradually converging to the north, and may actually converge northward or upwards, or both. The Division concluded (UDOGM, October 20, 1998 Field Visit Form) that:

- Joints and faults have good continuity vertically and along strike, which is roughly N-S. Ground-water flow from north to south would be facilitated along these fractures.
- There are thick unfractured sections between fractures, and lateral interconnectivity between joints and faults is not as well developed: east-west flow would be impeded relative to north-south flow.

Although the terrain is steep, the extensive jointing could allow local recharge from precipitation and snowmelt. However, flow at Birch Spring does not vary seasonally. Tritium is absent from the water, and mean residence time of the water is 9,000 years. Together, these indicate the fractures around Birch Spring do not provide significant recharge to the Birch Spring ground-water system.

### **Local Faults and Fissures**

Local faults and fissures also influence ground-water movement. Fault zones associated with boundary and interior faults may conduct ground water parallel to the faults. The Star Point Mine Plan (pages 700-6 and 700-7) states the following:

1. "...The secondary permeability resulting from open fractures created along faults and joints provides the primary conduit system for movement within the Wasatch Plateau..."

2. "...The extension joints and faults which strike in a north-south direction are generally open, and as such increase the secondary permeability. .... The open nature of these joints and faults and the attendant secondary permeability may be primarily limited to the sandstone units within these formations..."
3. "...Secondary permeability within the grabens is expected to be greater than secondary permeability outside of the grabens. Joint densities within the Bear Canyon Graben are approximately 50 percent greater than joint densities on either side of the graben..."

It has been hypothesized that at least part of the recharge for Big Bear Spring is conveyed from Big Bear Creek by way of local fractures. This is supported by isotopic data that indicate the water discharging from Big Bear Spring has a modern component (water in Birch Spring has no modern component; Bear Canyon Mine Plan, Appendix 7-J, Table 4). However, the large difference in stable isotopic ratios between Bear Creek and Big Bear Spring indicates that the creek does not contribute a significant quantity of water to Big Bear Spring (Bear Canyon Mine Plan, Appendix 7-J, p. 97).

[Parallel to the major boundary faults - the Bear Canyon Fault and the Trail Mountain Fault (East Fault of the Pleasant Valley Graben) - and extending inward are two fault zones approximately 200 to 250 feet in width. Spring flows in these zones appear to respond quickly to snowmelt and rainfall, indicating the vertical permeability from fractures in the region is relatively significant. Water seepage of from 1 - 20 gpm was observed to travel along these fractures, depending on the gouge or breaking character of the fault (Pre-1996 Star Point Mine Plan).]

### **Dip of the Strata**

In the Gentry Mountain CIA there is a structural high in the area around Nuck Woodward Canyon and the head of Corner Canyon that results in dip of 1 to 3 degrees to the south in most of the CIA. Dip angles increase near faults to about 20 degrees (Bear Canyon Mine Plan). Although dip is neither a necessary condition for ground-water flow nor a sufficient condition for ground-water flow, the dip of the strata is a major factor governing local and regional flow directions in the CIA.

In the Gentry Ridge Horst between the Bear Canyon and Pleasant Valley Grabens, the coal seams in the Star Point Mine dip approximately 3 degrees to the south-southwest, and the dip and general direction of ground-water movement is to the southwest in the perched aquifer system of the Price River - North Horn Formations north of Tie Fork Canyon. The structural high is at the head of the North Fork of Corner Canyon (Plate 31 in Spieker, 1931); it is north of the topographic high, which lies between the heads of South Fork of Corner Canyon and Gentry Hollow, above the Star Point Mine (Maps 5 and 6). A structural low has been mapped near the head of the Left Fork of Fish Creek (Spieker, 1931; Brown and others, 1987). Piezometers indicate a possible recharge mound under Gentry Mountain, and Gentry Ridge Horst and Bear Canyon Graben probably receive some recharge vertically from the overlying surface, mainly through fractures. However, the regional potentiometric surface matches geologic structure and dips from north to south through the mine area (Map 722.100c, Star Point Mine Plan), indicating

recharge comes from the north. Water not discharged from this system at Upper Tie Fork Spring continues to the south. South of Tie Fork Canyon, dip in the Bear Canyon Graben is southeast, directing flow toward the Bear Canyon Fault.

East of the Bear Canyon Fault, within the previously mined areas, the dip and direction of ground-water movement are to the east and southeast. Localized variations within the coal seams may determine the ultimate direction of water flow following mining. Structural contour maps supplied in the Hiawatha Mine plan (plates 6-6, 6-9, 6-12) indicate the dip within the Hiawatha Mine workings is southwest toward the Bear Canyon Fault in the western half of the workings and south in the eastern half of the workings.

### **The August 1988 Earthquake**

According to PMC personnel and the University of Utah Seismology Department (Nava and others, 1990), the area experienced several earthquakes during the fall of 1988. Information including dates and earthquake magnitude for the four largest earthquakes identified during this period (centered approximately 15 miles east of Ferron, Utah and 29 miles southeast of the Tie Fork Springs) as provided by the University of Utah include:

<b>Date</b>	<b>Time</b>	<b>Magnitude</b>
August 14, 1988	1:07 p.m.	3.8
August 14, 1988	2:03 p.m.	5.3
August 15, 1988	8:50 a.m.	3.0
August 18, 1988	6:57 p.m.	4.4

A flow increase recorded at Upper Tie Fork Spring in August 1988 correlates with the August 14, 1988 earthquake. The changes that occurred at Birch Spring at this time might also have been due, at least in part, to this seismic activity (Figure 2). This is discussed further in several sections of this CHIA.

## **HYDROLOGIC RESOURCES**

Surface- and ground water resources within the CIA are described. Water rights associated with some of the more important resources are presented, along with descriptions of their hydrology and geology.

### **Watersheds in the CIA**

The CIA is contained within two major river basins, the San Rafael River Basin and the Price River Basin. Sub-basins, surface-water monitoring sites, and UPDES water monitoring sites are shown on Map 6. The sub-basins in the Price River Basin on Map 6 are Sand Wash (1), Miller Creek (2), Serviceberry Creek (3), Mud Water Canyon (4), and Corner Canyon (5). The sub-basins in the San Rafael River Basin are Nuck Woodward (6 and 7), Tie Fork (9, 10, and 11), Trail Canyon – McCadden Hollow (13), Bear Creek (15), Fish Creek (16), Cedar Creek (18), and Miscellaneous Huntington Creek tributaries (8, 12, and 17).

## **GROUND WATER**

### **Water Rights**

Ground water within and adjacent to the CIA is used for wildlife, stock watering, domestic, industrial, and municipal purposes. Development of coal mines and power plants in Emery County and associated population growth, beginning in the 1970s, resulted in the transfer of more than one-third of the region's water from agricultural to industrial and municipal uses. Utah Power, now Rocky Mountain Power, acquired large blocs of stock in Huntington-Cleveland Irrigation Company (HCIC) along with stock in Cottonwood Creek Consolidated Irrigation Company and a long-term lease for water from Mill Site Reservoir. This shift in water use required retirement of some agricultural lands from cultivation and a reduced water supply to additional lands. Enlarged storage facilities and improvements in water distribution and irrigation practices have somewhat mollified the impacts to agriculture.

HCIC, a Utah mutual nonprofit irrigation company, has provided water to the Huntington, Cleveland, and Elmo areas since 1875. It serves 660 stockholders (154,694 shares of Class A stock at 0.5 acre-feet/share, and 14,474 shares of Class B stock at 1.0 acre-feet/share). Over the years, HCIC irrigated farmland has varied between about 16,000 and 24,000 acres, depending on water supply. HCIC holds water rights to 392.5 cfs (284,000 acre-feet/year) from various spring and surface-water resources in Huntington Canyon, but water resources in the canyon are over-appropriated and cannot match that volume.

Castle Valley Special Service District (CVSSD), a shareholder in HCIC, was organized in 1976 in order to fund water, sewer, and road projects. CVSSD delivers, by contract, up to 681 acre-feet of culinary water to the cities of Huntington, Cleveland, and Elmo. CVSSD does not provide irrigation water.

North Emery Water Users Special Service District (NEWUSSD, formerly North Emery Water Users Association, NEWUA) is a shareholder in HCIC. NEWUSSD provides culinary water to Lawrence, Huntington Canyon, Huntington Airport, and areas outside city limits in northern Emery County. The District does not provide irrigation water.

### **Water Rights Associated with Wells**

Wells developed as a water source are scarce in the CIA. The Bear Canyon Mine Plan identifies Water Right E1621, owned by Utah Power and Light, as a well. Table 724.100a of the Star Point Mine Plan lists one water right for an in-mine well: water right 91-3555 was used to supply domestic and mining water for the Star Point Mine. Upper and Lower Tie Fork Springs are sometimes referred to as wells, but they are discussed in the following section.

### **Water Rights Associated with Springs**

The USFS has filed for water rights on many springs on Gentry Mountain. Stock watering is the predominant water-right use associated with these springs, but they are also used

by wildlife.

Ground-water rights on 90 springs are listed in Table 724.100a of the Star Point Mine Plan, plus the Star Point Mine in-mine well discussed in the previous section. Stockwatering is the use listed for 83 of these water rights.

Domestic water rights 91-59 and 91-57 (PMC) are associated with springs in Sections 9 and 16, T. 15 S., R. 8 E., in Sagebrush Canyon, where the Star Point Mine portals were located. Water right 91-61 (PMC) is for springs at the south end of Long Point (Section 17, T. 15 S., R. 8 E.). Water rights 91-103 and 91-104 are held by U. S. Fuel Company on several springs in the headwaters of the Middle and Left Fork of Miller Creek. Getty Oil Co. holds water right 91-4295, for coal exploration-drilling, on a spring fed stock pond on Gentry Ridge (Section 13, T. 15 S., R. 7 E.). HCIC holds water right 93-219 on Upper Tie Fork Spring and Lower Tie Fork Springs (Table III-2): use is irrigation, domestic, stockwatering, and power.

Star Point Table 724.100a does not include all water rights in the CIA. The Hiawatha Mine Plan Tables 7-3 and 7-4 list 41 additional ground-water rights in and near the Hiawatha Mine permit area: 3 domestic (individuals), 4 industrial (AMR), 12 irrigation (HCIC), and 22 stockwatering (13 USFS, 2 State of Utah, and 7 individuals). The Bear Canyon Mine Plan does not list water rights but instead gives the URL for the Division of Water Rights Web Page.

CVSSD has developed Upper and Lower Tie Fork Springs for domestic use. Three boreholes encountered a pressurized aquifer at the confluence of Wild Cattle and Gentry Hollows, near existing springs. Two of the boreholes (identified by PMC as 86-35-2 and 86-35-3 and jointly labeled 86-35-2-3 on Maps 3, 5, and 6) were originally drilled as seismic exploration shot holes. CVSSD developed them as Upper Tie Fork Spring and hooked them into the water system in 1982. The third borehole (identified in the Star Point Mine Plan as 85-35-1) was a CPM coal exploratory hole that was deeded to Huntington City to supplement flow from Upper Tie Fork Spring. It was developed and hooked into the system in 1988. Because of down-hole problems, the flow from 85-35-1 was disconnected from the Upper Tie Fork system about a year later (Personal communication, Darrel Leamaster, Manager for CVSSD, February 13, 2007). In October 1993, Upper Tie Fork Spring was removed from the drinking water system, under an agreement with PMC, because a potential for mining impacts was identified at the Star Point Mine. Lower Tie Fork Spring was developed and put into the CVSSD system at this time to replace the diverted Upper Tie Fork Spring flow.

Birch and Big Bear Springs have a number of associated water rights. These rights are summarized and presented in Table III-2. One water right associated with Birch Spring, owned by Nevada Electric Corporation, has a designated stockwatering use for 30 head of cattle at the spring source. This use is incompatible with the domestic use; however, the area around the spring is fenced and has not been grazed for many years. Big Bear Spring, also called Bear Canyon Spring, is referenced as Big Bear Spring in this document because it is the name associated with this water right. **Table III-2**

Source	Water Right Number	Quantity	Priority	Owner
Birch Spring	93-304	150 cfs	1875	HCIC
	93-2198	80 cfs	1875	HCIC.
	93-2197	77.25 cfs	1884	HCIC
	93-2196	45 cfs	1879	HCIC
	E2504 93 3703	0.00 cfs (see the following paragraph)	1887	Castle Valley Special Service District (CVSSD)
	93-143	0.011 cfs	1875	Nevada Electric
Big Bear Spring	93-2201	80 cfs	1888	HCIC
	93-2200	77.25 cfs	1884	HCIC
	93-2199	45.0 cfs	1879	HCIC
	93-253	150 cfs	1875	HCIC
Upper and Lower Tie Fork Springs (wells)	93-219	150 cfs 162 acre-ft	1875	HCIC
	93-2220	45 cfs	1879	HCIC
	93-2221	77.25 cfs	1884	HCIC
	93-2222	80 cfs	1888	HCIC

1 - Information was obtained through the State of Utah Water Rights Internet site., which makes no claims as to the accuracy of the information.

### Water Rights Associated with the Mines and Mine Water

#### *Star Point Mine*

Water right 91-3555 (already mentioned in the discussion on wells) is held by PMC for an in-mine well. When in operation, water was pumped to the surface to provide a domestic water supply for the office facilities.

#### *Hiawatha Coal Mine*

The main water resources associated with the Hiawatha Mine are the mine-water discharge points (Table III-3). Co-Op has rights to some springs in the area south of Hiawatha, and ANR holds water right 91-174 (application a4656) that allocates a diversion of 3.3 cfs from the Left Fork of Miller Creek for domestic and mining uses.

Source	Right Number	Quantity	Priority	Owner/Use
King #1 Tunnel	91-251 a29532	0.942 cfs	1875	ANR /Industrial and Municipal

**Table III-3: Hiawatha Mine Water Rights**

Source	Right Number	Quantity	Priority	Owner/Use
	91-316 a6963	0.058 cfs	1989	ANR /Industrial and Municipal
Mohrland Mine Seeps and Drains	93-1089	0.446 cfs	1884	U. S. Fuel/ Irrigation

*Bear Canyon and Trail Canyon Mine*

Water right 93-3657 is controlled by the Co-Op Mining Company. Use is irrigation (19 acre-ft), domestic (19 families), and mining (2.45 acre-ft). Diversion is from a number of sources controlled by HCIC, but change a15965, 15 acre-ft, is for the points of diversion associated with the old Community Mine in Trail Canyon and the Bear Canyon Mine Portal (Sections 22 and 24 of T. 16 S., R. 7 E.).

C. O. P. Coal Development Company holds water right 93-1067, including change a13694, for water diverted from the Bear Canyon Tunnel. Permitted rate is 0.25 cfs, and the water is used to fill the two 10,000 gallon tanks near the mine. This right is for multiple uses: irrigation, domestic, mine shower facilities, and coal mining. Overflow from the tanks is discharged to Bear Creek at UPDES discharge point UTG04006-004.

**General Ground-water Quantity**

*Recharge*

Recharge is controlled by climate and the physical factors that allow the underground transport of water. Water must be available in excess of soil, plant uptake and evaporation losses in order to contribute to ground-water recharge. Moist climatic periods allow the rate of ground-water transport to reach its potential. Snowmelt at higher elevations provides the majority of the recharge to ground water in this region. Streams and reservoirs may also contribute to recharge, but the extent of this recharge is unknown. Figure 14 illustrates the climate conditions experienced over the last 25 years based on the PHDI.

Recharge in the Wasatch Plateau and Book Cliffs Coal Fields has been estimated to be three to eight percent (Danielson and Sylla, 1983) and nine percent (Waddell and others, 1986) of the average annual precipitation. Snowmelt provides most of the ground-water recharge. Star Point Mine personnel estimated that four percent of the total annual precipitation recharges the local systems, based on the assumption that long - term recharge equals long-term discharge (Aquifer Recharge Characteristics, Star Point Mine Plan). The normal annual precipitation for the higher elevations is 16 to 30 inches, of which 10 to 25 inches normally falls during October through April. Snowpack at these higher elevations commonly accumulate to depths of ten feet or more (Jeppson and others, 1968).

Recharge to the perched aquifer systems of the Price River and North Horn Formations is primarily from snowmelt along the flatter ridge top areas and in local basins. Gentler slopes in these areas allow snowpack accumulation and slower runoff, which provide opportunity for water infiltration.

Some springs, such as Lower Tie Fork, respond to seasonal precipitation and recharge, while others, such as Birch Spring and Upper Tie Fork, show little seasonal variation. Flows at Little Bear and Big Bear Springs have a seasonal component imposed on a more consistent baseflow (Figures 2 and 14a), although the extreme seasonal variation seen at Big Bear Spring from 1980 to 1986 is absent

Once recharge enters the ground, the rate and direction of flow is governed mainly by gravity and geology. Lateral flow dominates in the gently dipping Tertiary and Cretaceous strata of the Wasatch Plateau, where layers of low-permeability rock that impede downward movement and plastic or swelling clays that can seal faults and fractures are common. Typically, ground water infiltrates at higher elevations in the Wasatch Plateau and flows both laterally and downward until it reaches the surface and is discharged as a spring or seep, enters a stream as baseflow, is transpired by vegetation, or simply evaporates from the unsaturated zone.

Ground water tends to flow more readily through shallower systems because the hydraulic conductivities are generally larger than those of deeper systems, but some ground water reaches deeper flow-paths. The flow path of ground water along joints, fractures, and faults to deeper strata can be complex and the volume or rate of recharge difficult to quantify. Recharge will more readily move to deeper zones where there are fractured and coarsely brecciated fault zones, where fractures are open due to tension, and where clays and fine-grained gouge are absent. Flow will be impeded where compression has closed fractures, where movement on fault planes has produced fine-grained gouge, and where faulted strata are rich in clays.

Map 5 illustrates the distribution of springs in the area in relation to the various geologic strata. The North Horn Formation (TKn) supports the greatest number of springs (Table III-4). These springs generally have small flows, but the total flow is large (Bear Canyon Mine Plan, Appendix 7-J, Section 4.1). Recharge to these shallow ground-water systems is by direct infiltration from the surface through fractures and solution cavities in the Flagstaff Limestone and permeable layers and fractures in the North Horn. Seeps and springs typically occur along downdip exposures of these strata, the result of ground-water flow along sandstone-shale contacts. However, many of these springs are fracture related, and springs associated with fractures and faults may have a recharge area that extends beyond the immediate watershed. Discharge from fractures in the shallower strata indicates shale or mudstone has sealed or blocked the fracture, directing flow to the surface and limiting downward recharge to deeper strata.

<b>Table III-4</b>						
<b>Summary of Spring Inventory Data By Geologic Formation</b>						
(From Hiawatha Mine Plan, Table 7-2 and Exhibit 7-2; Star Point Mine Plan, p. 700-19; some springs were undoubtedly counted by both operators Figure 6 of Appendix 7-J in the Bear Canyon Mine Plan presents similar information)						
Formation	Number of Springs Found		Percent of Total		Predominant Flow Rate (gpm)	
	Hiawatha	<u>Star Point</u>	Hiawatha	<u>Star Point</u>	Hiawatha	<u>Star Point</u>
North Horn Formation	82	154	52	75	2-8	
Price River Formation	23		14		2-8	
Castlegate Sandstone	16	25	10	12	2-5	
Blackhawk Formation	28	10	18	5	Seep	>3
Star Point Sandstone	9	8	6	4	10-100	
Mancos Shale	<u>1</u>	<u>7</u>	<1	3	Seep	
Total	159	204				

The fractured and brecciated zones associated with the major faults appear to be important recharge paths, especially for larger, deeper systems. Ground-water contours around the Star Point Mine indicate a source of ground-water recharge to the north, from the direction of Nuck Woodward Canyon (Star Point Mine Plan, Map 722.100c). The Trail Canyon Fault runs along or near the streambed in Nuck Woodward Canyon and into the western parts of the Star Point Mine. A stream survey completed for the Star Point Mine in 1992 identified losing stream sections in Nuck Woodward canyon. The stream survey included the entire reach of Nuck Woodward canyon adjacent to the Star Point Mine. Information found in Table 728f in the Star Point Mine Plan indicates a majority of the stream appears to be losing water. Reach decreases were as much as 33 gpm (Star Point Mine Plan, pp. 700-68 and -69).

The Mancos Shale is a thick aquitard that effectively blocks further downward infiltration of ground water. The largest natural springs in the Gentry Mountain CIA, Big Bear and Birch, flow near the Mancos - Panther Sandstone contact.

### **Aquifers**

In the Gentry Mountain area, ground water issues from all exposed strata, from Mancos to North Horn (Table III-4). The two major water-bearing units in the CIA are the Star Point Sandstone and the combined North Horn - Price River Formations. These units are modified by north-south normal fault systems that can act as either boundaries or conduits to ground-water flow, and sometimes act simultaneously as barriers to flow across the fracture but as conduits for flow parallel to the fracture. North-south trending normal faults control the hydrologic regimen on the west side of the CIA, and provide local influence throughout the CIA. Structural dip also imposes some control on ground-water flow direction: west of the Bear Canyon Graben, strata dip generally to the south-southeast, and east of the Bear Canyon Graben, to the south or southwest.

The largest number of springs is in the North Horn - Price River Formations, and these strata probably yield the greatest volume of water (Table III-4; Bear Canyon Mine Plan, Appendix 7-J, Section 4.1). Data from a variety of sources indicate hydraulic conductivities in the Star Point Sandstone and Blackhawk Formation are too low for these strata to be an effective regional aquifer (Appendix D). The largest springs, Upper and Lower Tie Fork, Birch, and Big Bear Springs, issue from fractures in the Star Point Sandstone. Big Bear and Birch Springs issue from fractures in the Panther Sandstone Member, which is the lowest unit of the Blackhawk Formation and lies just above the thick, main body of the nearly impermeable Mancos Shale.

#### *The North Horn - Price River Formations*

In the CIA area, the most significant perched aquifer systems are in the Price River and North Horn Formations. These seeps and springs typically have small flows and occur along downdip exposures, the result of dip-controlled ground-water flow along sandstone – shale contacts; however, many are fracture related. The majority of high elevation springs are located near Gentry Mountain Ridge above the Star Point Mine and along the south side of Gentry Mountain (Map 6). Discharge from the Price River and North Horn Formation perched aquifer systems drops off significantly from early summer to late fall, indicating limited storage (Star Point Mine Plan, p. 700-19).

In borehole 84-23-1 on Gentry Ridge, wet strata were identified at depths of 130 feet to 190 feet (elevations of 9,698 and 9,638 ft, respectively), and the 190-foot depth correlates with a sandstone-shale interface and numerous springs. Monitoring well 86-26-4 at the south end of Gentry Ridge located a water table in a perched system at an approximate elevation of 9,550 feet. This is 50 ft higher than the exposure of the sandstone-shale contact nearby, to the west and south, but the Star Point Mine Plan does not mention springs along this exposed contact (Star Point Mine Plan, p. 700-9).

The general direction of movement is to the southwest in the perched aquifer systems of the Price River and North Horn Formations within the Gentry Ridge Horst, between Bear Canyon and Pleasant Valley Grabens. Few springs issue from these formations south of McCadden Hollow (Map 5).

#### *The Star Point-Blackhawk Formations*

The Blackhawk Formation overlies the Star Point Sandstone, and, based on local characteristics, the Blackhawk and the Star Point may be in hydrologic connection. The Star Point Sandstone consists of, from highest to lowest, the Spring Canyon, Storrs, and Panther Sandstone Members. The sandstone members are composed of fluvial shales, siltstones, and channel sandstones.

Channel sandstones are inter-woven throughout the Blackhawk Formation and may appear somewhat discontinuous, but are associated with a large, ancient stream system. These channel sandstones may be linearly extensive except where they are dissected by faults. Saturated, fluvial-channel sandstones and other laterally discontinuous sandstone bodies in the

Blackhawk Formation yield water when encountered by mine operations. Clay is abundant throughout the Blackhawk Formation, producing localized perched aquifers

In the Hiawatha Mines, inflows have produced a continuous discharge from the Mohrland portal of approximately 400 gpm since at least 1983 (Figure 1), and most of this flow is from numerous, small inflows from channel sandstones. Based on Hiawatha Coal Company information, it appears that all the major inflows encountered to date have been in the B Seam, stratigraphically the highest coal seam mined at Hiawatha. Water discharging from the abandoned mine workings contains 5.5 TU and has a radiocarbon age of 9,000 years, indicating that the water is a mixture of modern waters with waters in excess of 9,000 years old (Mayo, 2001).

Hydraulic conductivity and transmissivity data for the Wasatch Plateau Coal Field are summarized in Appendix D. Primary permeability within the Star Point Sandstone and overlying Blackhawk Formation is quite low, but varies laterally and vertically. Star Point Sandstone transmissivities measured by slug tests in bore holes at the Bear Canyon Mine (Appendix 7-N, Section 4) ranged from 0.07 to over 50 ft<sup>2</sup> /day ( $1.1 \times 10^{-3}$  to over 0.5 cm<sup>2</sup>/sec, indicating hydraulic conductivities of approximately  $2.8 \times 10^{-6}$  to  $2.6 \times 10^{-4}$  cm/sec). Price and Arnow (1974) characterize the sedimentary rocks in this region as having low permeability and specific yields of only 0.2 to 2 percent.

The saturated zone extends up into the Blackhawk Formation within the southern portions of the Star Point Mine in the Gentry Ridge Horst, between the Bear Canyon and Pleasant Valley Grabens. Mining conducted in 1991 verified that water was present both within and above the Star Point Sandstone. East of the Bear Canyon Graben, the Blackhawk Formation is not saturated (Star Point Mine Plan, Exhibit 7-28h).

Spieker (1931) identified the three Star Point Sandstone tongues at outcrop exposures both north and south of the CIA, but in exposures in upper Huntington Canyon to the west and in Pleasant Valley to the northwest, the Star Point is a massive sandstone with no shale. None of the boreholes in the Star Point Mine area penetrated the entire Star Point Sandstone, so it is not certain that three distinct sandstone tongues are present there. At the Bear Canyon Mine to the south, down gradient and down dip, the Star Point Sandstone tongues are distinct, separated from each other by tongues of Mancos Shale, and they have separate potentiometric surfaces (Bear Canyon Mine Plan, Plates 7J-1 and J-2).

Information from mines and boreholes in the CIA indicates water movement is lateral within the three Star Point Sandstone tongues and that vertical movement is minimal, therefore recharge to the Star Point must occur primarily at fractures and outcrops. Recharge may be slow where fractures are due to compression or have been closed or sealed by gouge and clays or other sediments. Where fractures are more numerous or have been opened by tension, and in brecciated zones adjacent to faults, recharge rates may be rapid. Secondary permeability resulting from open fractures was identified as the primary conduit system for movement within the Star Point Mine.

Water that was encountered within the Hiawatha Mine predominantly originated while mining in the B Seam, the highest seam, especially the large flow through the floor where the 10<sup>th</sup> West Section of the King 4 Mine intercepted the Bear Canyon Fault (Hiawatha Mine Plan, Plate 7-22). Mining of the Hiawatha Seam, which lies closest to the Spring Canyon Member of the Star Point Formation, was relatively dry and produced minimal water. The majority of mining in the Hiawatha Seam (Hiawatha 1 and 2 and King 1, 2, 3, and 4 Mines) was down-dip of mining in the overlying B and A Seams (King 4, 5, and 6 Mines). These observations indicate that the Hiawatha Seam in the Hiawatha Mine complex is not saturated and that fractures do not readily conduct water up from the Star Point Sandstone when the overlying coal is mined.

The Star Point Mine conducted a seep and spring survey in 1986 and did a follow-up in 1991. Of the ten springs found issuing from the Blackhawk Formation, five were in Little Park Canyon, west of the Bear Canyon Fault; three were along or near Trail Canyon Fault in Wild Cattle Hollow, near its junction with Gentry Hollow; one was in Mud Water Canyon; and one was in Seeley Canyon. One spring flow rate was 11 gpm, while all other Blackhawk spring flow rates were 3 gpm or less (Star Point Mine Plan, p. 700-19. Unfortunately, the Star Point Mine Plan does not identify these springs. The springs shown on Maps 5 and 6 undoubtedly include some of them).

Other than Big Bear, Birch, and the Tie Fork Springs, few springs in the CIA flow from the Blackhawk Formation and Star Point Sandstone (Map 5). SBC-14 flows from the Spring Canyon Sandstone in the right fork of Bear Canyon, just below the #3 Mine portal. Springs 16-7-24-3 and SBC-17 discharge from the Blackhawk Formation immediately east of the Bear Canyon Fault in Bear Canyon. FBC-11 flows from the upper Blackhawk, west of the Pleasant Valley Fault. Star Point Mine personnel measured a substantial gain in flow where the North Fork of the Right Fork of Miller Creek crossed the Storrs and Panther Members of the Star Point Sandstone (Star Point Mine Plan, p. 700-23), and other streams may gain flow where they pass over these strata.

The Star Point Mine identified seven springs that issue from the Mancos Shale. The two largest, in Seeley Canyon, issue from faults. Although a fault could not be associated with the other five Mancos Shale related springs, it is likely that these springs receive water from the overlying Star Point Sandstone through faults or fractures (Star Point Mine Plan, p. 700-19)).

### **General Ground-water Quality**

The quality of the upper Cretaceous sediments in the Wasatch Plateau is characterized by total dissolved solids (TDS) concentrations less than 1,000 mg/L. The TDS measured in springs, wells, and mines issuing from or completed in the formations are reported for the Wasatch Plateau and Book Cliffs areas by Waddell and others (1981) as:

- Price River Formation 122-792 mg/L
- Castlegate Formation 315-806 mg/L
- Blackhawk Formation 63-796 mg/L
- Star Point Sandstone 355-391 mg/L

The local characteristics are summarized below for each formation. The Mancos shale is also included because some springs were found issuing at the top of the formation.

Isotopic analysis is becoming increasingly important for determining ground water mean residence time, which is often simply called the age of the water. Tritium and radiocarbon analyses are the primary isotopic methods used in age-dating water. Sometimes a unique isotopic identifier can help establish the water's origin.

Table 4 in Appendix 7-21 of the Hiawatha Mine Plan outlines a study of ground-water age. Tritium in 10 springs that discharge from the Flagstaff Limestone, North Horn Formation, Price River Formation, and the Blackhawk Formation ranged from 12 to 32 TU. This indicates modern recharge to these springs, the water being held in the formation for only a short time before being discharged. This conclusion is supported by radiocarbon ( $^{14}\text{C}$ ) analyses, which indicate the number of years since the ground water became isolated from soil-zone gases and near-surface waters.

#### *Price River-North Horn Formations*

These formations are entirely above all mine workings. Springs from these formations respond quickly to seasonal precipitation. Water is locally recharged and discharged at nearby springs. Water quality from these formations is adequately described through spring water-quality analyses. The Price River and North Horn Formation ground waters are similar, having the primary chemical constituents of calcium and bicarbonate. At certain locations, particularly along Gentry Ridge where the Flagstaff Formation also is present, magnesium becomes a more dominant cation than at the other locations, probably due to the solution of dolomite. TDS concentration is generally less than 300 mg/L. The mean concentration of TDS for springs monitored by PMC from 1979 to 1990 from the Price River and North Horn perched system varied from a low of 124 mg/L to a high of 298 mg/L. In general, TDS concentrations are higher in the fall than in the early summer due to localized snowmelt and short residence time (Star Point Mine Plan).

#### *Blackhawk Formation*

Ground water from the Blackhawk Formation is a mixed type with no single dominant cation or anion. Springs from the Blackhawk Formation tend to be a calcium bicarbonate type, but waters from the Blackhawk can contain significant concentrations of magnesium and sulfate, and pH is generally somewhat alkaline. TDS concentrations tend to vary inversely with flow. Water quality can be better where springs issue from fractures and are recharged locally. Within the mines, some waters from the Blackhawk may be old and may have higher concentrations of TDS, magnesium, and sulfate.

#### *Star Point Sandstone*

Ground water from the Star Point Sandstone is a mixed type with no single dominant cation or anion. Water quality can be better where springs issue from fractures and are recharged

locally.

### *Mancos Shale*

Sulfate concentrations may increase because of contact with shales having a high sulfide concentration.

## **SURFACE WATER**

Surface waters from within the CHIA flow to both the Price River and San Rafael River Basins. These basins discharge to the Green River, which joins the Colorado River (Map 1).

The Price River Basin is located primarily within Carbon and Emery Counties and has an area of approximately 1,800 square miles. The Price River originates in the Wasatch Plateau, at the outlet of Scofield Reservoir. The river flows east-northeast from Scofield Reservoir and then turns and flows to the south-southeast. The Price River drainage basin is bounded by the Book Cliffs to the north-northeast and the Wasatch Plateau to the northwest, with the divide that extends from Gentry Ridge to Cedar Mountain forming the southern boundary within the Wasatch Plateau. Flow from the CIA enters the Price River south of Wellington, Utah (Map 1).

The San Rafael River Basin is located primarily in Emery County and lies south of the Price River Basin. This drainage basin covers approximately 2,300 square miles. The San Rafael River Basin drains sections of the Wasatch Plateau and the San Rafael Swell north of San Rafael Nob. Three major tributaries - Huntington, Cottonwood and Ferron Creeks - converge to form the San Rafael River. Huntington Creek is the primary surface-water resource in the San Rafael River Basin, draining the southeast portion of the CIA. The San Rafael River flows into the Green River (Map 1).

### **Surface-water Rights**

Local water development in the region is primarily focused in the Huntington drainage, which flows to the San Rafael River. Water reservoirs were constructed in the Huntington Creek headwaters adjacent to the CIA, and the west and southwest regions of the CIA drain to Huntington Creek. The primary water users are NEWUSSD and HCIC, which hold rights for domestic and municipal uses. CVSSD delivers water to the cities of Huntington (500 acre-ft), Cleveland (114 acre-ft) and Elmo (67 acre-ft). The total quantity of use granted to the HCIC is 392.5 cfs from the various spring and surface-water resources in Huntington Canyon. Other water rights associated with springs of the CIA may contribute to down stream surface-water rights.

Drainages on the east side of the CIA report to the Price River by way of Miller Creek, Gordon Creek, and several washes. There are numerous water rights, mostly for stockwatering, on the springs and streams in these drainages.

## **Surface-water Quantity and Quality**

### *Watersheds in the CIA*

The CIA is contained within two major river basins, the San Rafael River Basin and the Price River Basin. Sub-basins, surface-water monitoring sites, and UPDES water monitoring sites are shown on Map 6. The sub-basins in the Price River Basin are Sand Wash (1), Miller Creek (2), Serviceberry Creek (3), Mud Water Canyon (4), and Corner Canyon (5). The sub-basins in the San Rafael River Basin are Nuck Woodward (6 and 7), Tie Fork (9, 10, and 11), Trail Canyon – McCadden Hollow (13), Bear Creek (15), Fish Creek (16), Cedar Creek (18), and Miscellaneous Huntington Creek tributaries (8, 12, and 17).

### *Price River Basin*

#### ***Sand Wash Drainage (1) and Miller Creek Drainage (2)***

Miller Creek (11,892 acres) and Sand Wash (6,082 acres) drain the southwest portion of areas associated with the Hiawatha and Star Point Mines. Miller Creek has an average gradient of 15 percent and Sand Wash has an average gradient of 17 percent. Flow in the North Fork of the Right Fork of Miller Creek is intermittent to perennial.

Approximately 350 disturbed acres from the Hiawatha Mine lie within the upper reaches of Sand Wash and the Right and Left Forks of Miller Creek. Miller Creek was permanently diverted along a reach adjacent to the coal processing waste pile. Hiawatha and Star Point Mines mined under Miller Creek. Cypress Plateau mined under the North Fork of the Right Fork of Miller Creek.

Of the 36 springs identified within the North Fork of the Right Fork of Miller Creek, 21 springs issue from the Price River - North Horn Formation, 14 springs issue from the Castlegate Sandstone, and 1 spring issues from the Star Point Sandstone. Total flow from these springs during a spring inventory conducted for the Star Point Mine was 99 gpm (0.22 cfs). This represented 86 percent of the 0.26 cfs flow from the North Fork of the Right Fork of Miller Creek.

#### ***Serviceberry Creek Drainage (3)***

Serviceberry Creek drains 6,321 acres within the CIA and has a 21 percent gradient, on average. East of the CIA, Serviceberry Creek is ephemeral and is tributary to Miller Creek. The Star Point Mine disturbed area (approximately 330 acres) lies primarily within the Serviceberry Creek drainage, and mining has occurred under the upper reaches of this watershed.

#### ***Mud Water - Los Angeles Canyons Drainage (4) and Corner Canyon Drainage (5)***

Mud Water and Los Angeles Canyons (3,040 acres) have a 19 percent gradient on average. The Corner Canyon drainage (6,951 acres) includes Seely and First Water Canyons.

Mud Water and Corner Canyon drainages converge to form Gordon Creek. The Gentry Mountain CHIA prepared in 1989 stated that Mud Water, Seeley, and the South Fork of Corner Canyon were perennial in their lower reaches due to high-elevation spring flows and mine-water discharge. Mines no longer discharge water to these drainages. These drainages are not monitored by any mine operator, and whether their lower reaches are still perennial is not certain. Mining occurred in the headwaters and ridges separating these drainages.

*San Rafael River Basin - Huntington Drainage*

Flow in Huntington Creek is controlled by three reservoirs upstream of and outside of the CIA: Electric Lake, Huntington, and Cleveland Reservoirs. Typically, a rapid increase in streamflow results from snowmelt between April and June. Climatic influences and water releases from the reservoirs control year-to-year variations.

PacifiCorp measures the flow in lower Huntington Creek monthly at two locations near the Deer Creek Mine: HC001 is just upstream and HC002 just downstream of the Deer Creek confluence. The PacifiCorp data show that from 01/28/1991 to 06/22/2006, flow in Huntington Creek at HCC01 averaged 27,400 gpm (61 cfs), with a maximum flow of 219,900 gpm (490 cfs) on 06/30/1995 and a minimum of 0 gpm (no flow) on 12/01/1993. Maximum and minimum values at HCC02 are the same, but average flow is slightly higher, 29,800 gpm (65 cfs), indicating the influence of Deer Creek and the Deer Creek Mine discharge on Huntington Creek.

The USGS monitored Huntington Creek at station 09318000 almost daily from 05/03/1909 to 10/04/1979 (U. S. Geological Survey NWIS, 2006). Mean daily discharge averaged 105 cfs, with a maximum of 1,310 cfs on 06/06/1952 and a minimum of 1.2 cfs on 12/17/1977 (Exhibit III-1). Extreme flows were 2,500 cfs on 08/02/30, and 0.87 cfs, which occurred twice - both during November - on 11/26/76 and 11/28/78 (Price and Plantz, 1987). 09318000 was approximately at the same location as Deer Creek Mine monitoring point HCC03 (Map 6).

On 04/25/1979, the USGS began monitoring Huntington Creek at 09317997, approximately 2 miles upstream of 09318000 and upstream of the Deer Creek confluence (Exhibit III-2). HCC01 is at approximately the same location (Map 6). Monitoring at 09317997 was done six out of the next ten years, until 09/30/1989 (U. S. Geological Survey NWIS, 2006). Mean daily discharge averaged 89 cfs, with a maximum and a minimum of 847 cfs (06/03/1986) and 8.1 cfs (12/08/1980), respectively. It is important to note that according to the Palmer Hydrologic Drought Index (Figure 14), 1981 through 1986 was a particularly wet period, and that flows from the Upper Huntington drainage are influenced by discharges from Electric Lake reservoir.

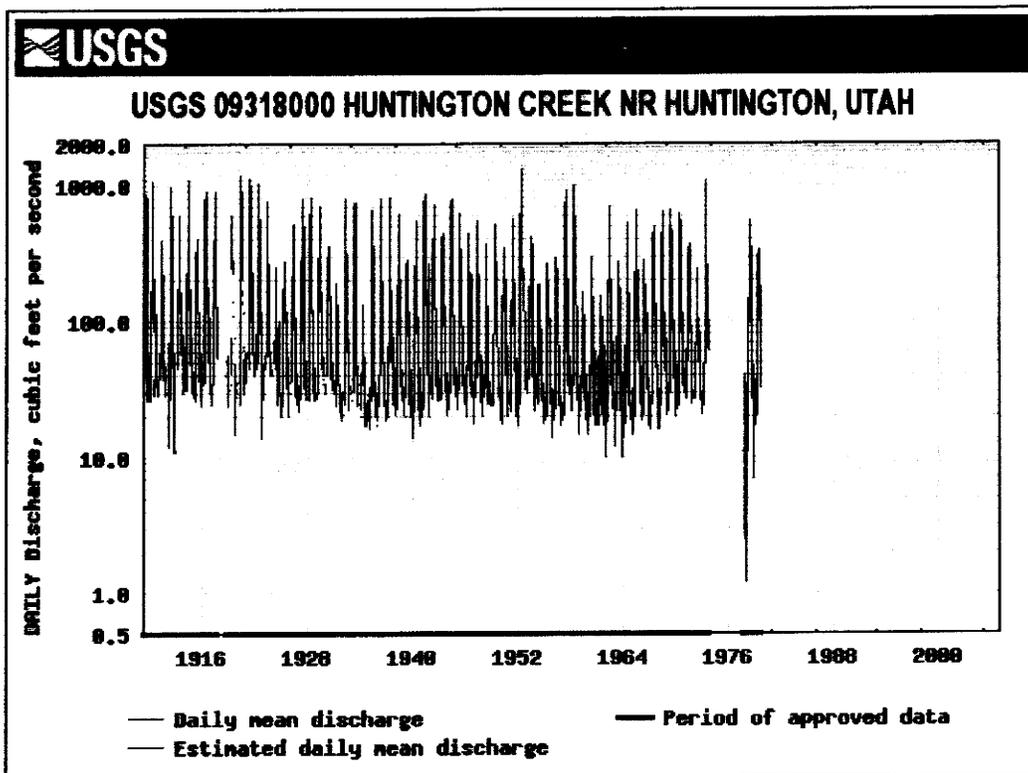


Exhibit III-1

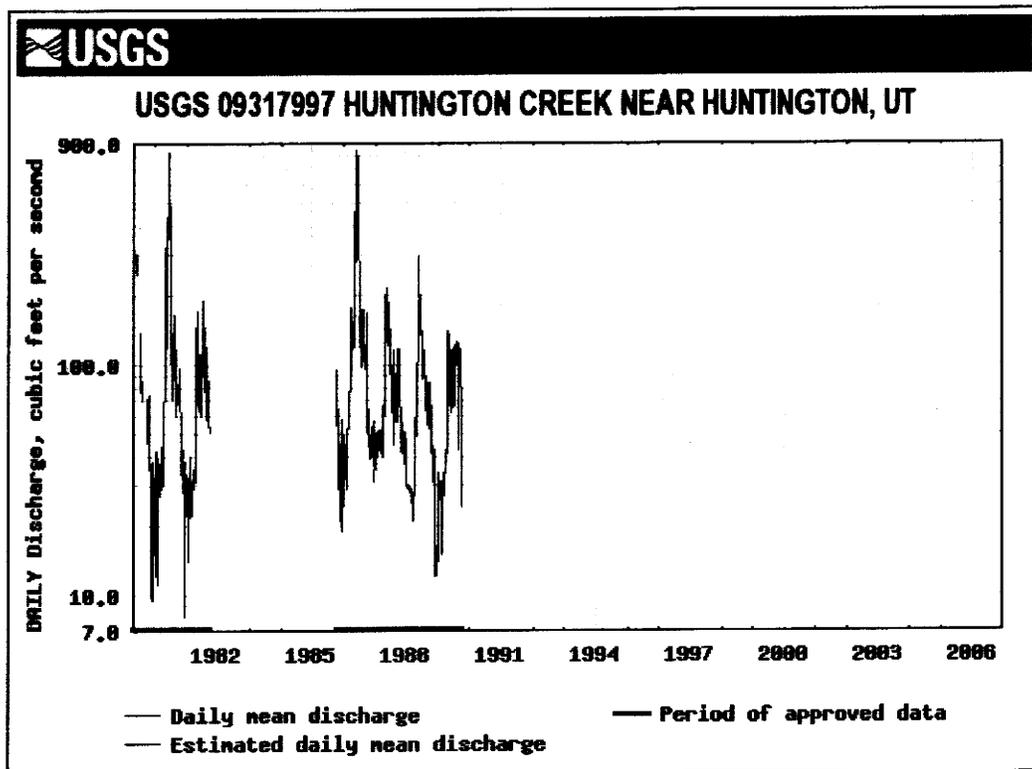


Exhibit III-2

### *Nuck Woodward (6) and (7)*

Nuck Woodward Canyon drains approximately 6,738 acres and is directly tributary to Huntington Creek. This drainage abuts the northwestern mined region of the Star Point Mine. The upper end of the canyon parallels the Trail Canyon Fault (East Fault of the Pleasant Valley Graben), and it is evident faulting determined the orientation of the upper canyon.

Ground-water contours around the Star Point Mine indicate recharge is from the north, from the direction of Nuck Woodward Canyon (Star Point Mine Plan, Map 722.100c). Extensive local faulting runs through the streambed in Nuck Woodward Canyon and into the western parts of the Star Point Mine. A stream survey completed for the Star Point Mine in 1992 identified losing stream reaches in Nuck Woodward Canyon. The stream survey included the entire reach of Nuck Woodward Canyon adjacent to the Star Point Mine: inflow from side drainage was only partially accounted for. Information found in Table 728f in the Star Point Mine Plan indicates the majority of stream reaches appear to be losing water. Significant reach decreases were as much as 33 gpm (Star Point Mine Plan, pp. 700-68 and -69).

Surface water in Nuck Woodward Canyon is thought to be connected to ground water in the Star Point Mine. The Star Point Mine Plan states, "Water flowing down Nuck Woodward Canyon is believed to be partially lost to this [Eastern Boundary] fault system whereafter it joins with deeper water moving within the fault. Water is then directed underground towards and through the permit area." (Star Point Mine Plan, Ground Water Source, p. 700-68).

Recharge from Nuck Woodward probably contributes to the flow in the Tie Fork Springs and may reach as far as Birch and Big Bear Springs in Huntington Canyon (Map 3). "It may also be possible for water to enter the fault in Nuck Woodward Canyon, move southward along the East Fault of the Pleasant Valley Graben, south-southeastward across Gentry Ridge toward the Western Boundary Fault of the Bear Canyon Graben [Trail Canyon Fault], then southward towards Birch and Big Bear Springs. The complexity and additional length of the water flow path greatly reduces the potential for impact on both Birch and Big Bear Springs by mining" (Star Point Mine Plan, Impact to Culinary Water Supplies, p. 700-83).

### *Tie Fork Drainage (11, 9, 10)*

Wild Cattle Hollow (2,759 acres) and Gentry Hollow (3,830 acres) join Lower Tie Fork Canyon (1,199 acres) to form the Tie Fork Drainage. The average gradient for Gentry and Wild Cattle Hollow is 13 percent and the Lower Tie Fork Canyon gradient is 44 percent. Location and orientation of Wild Cattle Hollow and upper Gentry Hollow were controlled by the Trail Canyon and Bear Canyon Faults, respectively.

The east side of Wild Cattle Hollow was undermined by the Star Point Mine Gentry Ridge workings, and east side of upper Gentry Hollow was undermined by both the Hiawatha and Star Point Mines. The Star Point Mine longwall panels abut Wild Cattle Hollow's main channel.

Both Gentry Hollow and Wild Cattle Hollow are designated perennial creeks on the USGS Hiawatha quadrangle map. Star Point Mine's monitoring of both streams just above their confluence (stations 34-01 and 34-2) from 1980 through 2001 indicates perennial flow, although there was one report of zero flow. Discharge rates for Tie Fork Canyon are available for USGS station 09317920 (Figure III-3) from 10/20/1977 to 10/07/1981 (U. S. Geological Survey NWIS, 2006). Measured mean daily discharge averaged 2.2 cfs. It ranged from 0 cfs (15 days between November 1977 and February 1978) to 29 cfs (five days in late May and early June 1980).

Springs were monitored within the Star Point Mine area and adjacent area in June/July of 1986 and were monitored again in August 1991. All 51 springs found within the Gentry Hollow surface-water drainage basin issue from the North Horn Formation. Total discharge from these springs in 1990 was 418 gpm (0.93 cfs). If it were assumed that there are no stream losses between the springs and the junction of Gentry and Wild Cattle Hollows, total spring flow would represent 71 percent of the 1.3 cfs total streamflow (Star Point Mine Plan).

From the 60 springs found within the surface-water drainage basin of Wild Cattle Hollow, 57 of the springs issue from the Price River - North Horn Formations. The three remaining minor springs issue from the Blackhawk Formation near the junction of Wild Cattle and Gentry Hollows. Total discharge from these 60 springs was 393 gpm (0.88 cfs), which represents 86 percent of the 1.02 cfs total streamflow measured in Wild Cattle Hollow (Star Point Mine Plan).

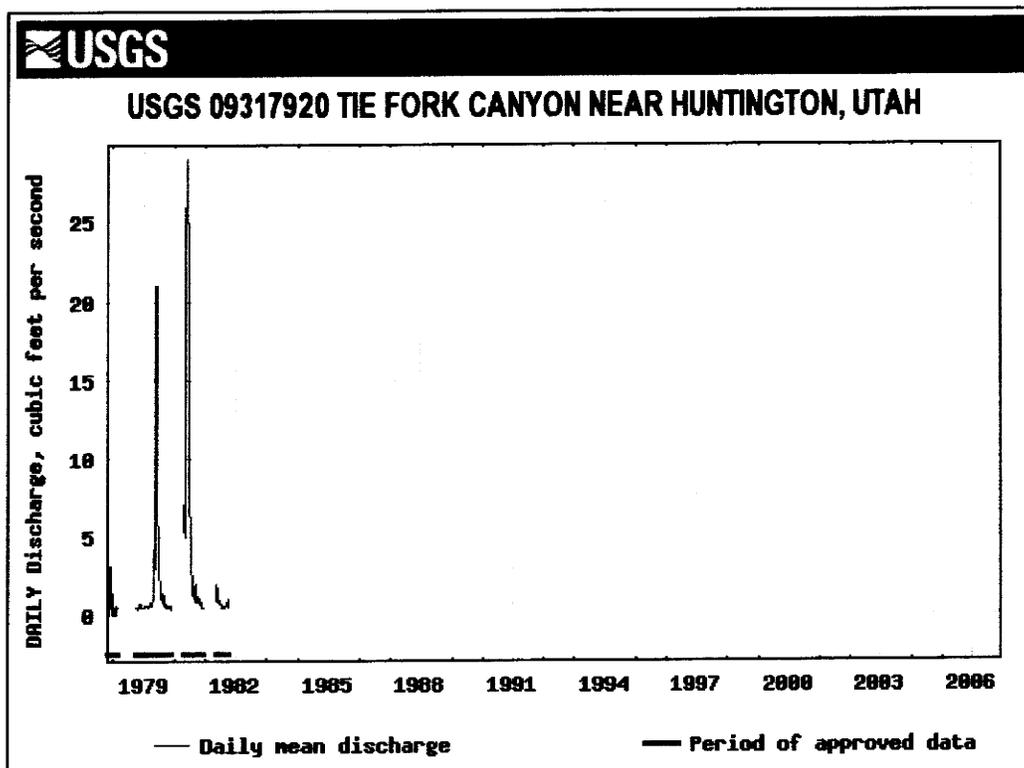


Exhibit III-3

### ***Huntington Creek Tributaries (8, 12, 14, and 17)***

Miscellaneous tributaries to Huntington Creek that originate within the CIA include: Pole Canyon, McElprang Canyon, Vicks Canyon, Grange Hole, Biddlecome Hollow (8), Blind or Dry Canyon - which includes Birch Spring (14), and two miscellaneous side drainages (12) and (17). The 46.22 permitted acres associated with the Deer Creek Waste Rock site lie within Watershed Area 17 (Map 6). The average gradients of the tributaries range from 40 to 70 percent.

### ***Trail Canyon – McCadden Hollow (13) and Bear Creek (15) Drainages.***

Trail Canyon drainage encompasses approximately 2,954 acres, including McCadden Hollow. Bear Canyon drainage includes approximately 2,029 acres. The average gradient of Trail and Bear Canyons is 20 to 25 percent. Location and orientation of Trail and Bear Canyons indicate they were eroded along the Trail Canyon and Bear Canyon Faults, and upper McCadden Hollow was eroded either along the Bear Canyon Fault or a nearby parallel fault.

Bear Creek lies below Gentry Ridge in steep, narrow canyons. It carries large sediment loads: Total Suspended Sediment (TSS) of 28,092 mg/L was measured during a major storm event. Sediment sources are the exposed bedrock along the boundary of the Gentry Ridge escarpments and the springs that issue along the Bear Canyon Fault where erosive lithologic units are exposed. Trail Creek (9) is characterized by a steep gradient, narrow canyons, and good water quality.

Approximately 10 surface acres have been disturbed in both the Bear Canyon and Trail Canyon drainages. Trail Canyon includes a residential area of about 14 acres that is not associated with the Trail Canyon Mine. The disturbed area associated with the Trail Canyon Mine is reclaimed and was released from the reclamation bond in January 2001.

Projected workings at the Bear Canyon Mine will undermine portions of upper McCadden Hollow and Bear Canyon.

### ***Fish Creek Drainage (16) and Cedar Creek Drainage (18).***

Fish Creek drainage encompasses approximately 5,288 acres, and the average gradient is 19 percent. Fish Creek is identified as a perennial stream in the Bear Canyon Mine PHC, but monitoring has been very sparse. These drainages have gone dry during periods of prolonged drought. From 1991 to 1994 flow ranged from 0 gpm to 65 gpm in the Left Fork; during 1996 and 1997 low flow was 15 gpm in both the Left and Right Forks. When the leases between Wild Horse Ridge and Cedar Creek were added to the Bear Canyon Mine in 2006, perennial reaches of both forks of Fish Creek were identified. Additional monitoring points were established along Fish Creek and at the springs that feed the streams. One concern was that subsidence would fracture the surface and divert flow from these streams directly into the mine workings, but overburden thicknesses appear sufficient to prevent this. In addition, the 7.32 permitted acres associated with the Burma Evaporation Basin lie within Watershed Area 16 (Map 6).

Cedar Creek drainage covers approximately 17,023 acres. The average gradient is 13 percent. The Right Fork is ephemeral and the Left Fork exhibits perennial characteristics in certain reaches due to mine-water discharge. Portions of the Hiawatha and Bear Canyon Mines lie within the Left Fork of Cedar Creek, and the Hiawatha Mine extends into the Right Fork. The Mohrland Mine surface facilities and disturbed area (approximately 25 acres) are adjacent to Cedar Creek. Mine water discharges continuously from the Mohrland Portal. Long-term plans for the Bear Canyon Mine include a portal in Cedar Creek Canyon, near the Mohrland portals but on the south side of the canyon.

### General Surface-water Quality

Stream	Date	Concentration (mg/L)	Load (tons/day)
Huntington Creek (09318000)	8-13-78	104	27
	11-17-78	72	2.5
	6-13-79	114	66
	8-7-79	44	15
Tie Fork Canyon (09317920)	8-13-78	12	0.03
	11-17-78	57	0.12
	6-13-79	38	0.68
	8-6-79	66	0.17
Bear Creek	10-25-78	8,860	1.9
	6-14-79	2,140	4.0

The State Division of Water Quality has classified waters in the Price River and its tributaries, below the Price City Golf Course, as Class 2B, 3C and 4. Huntington Creek waters in the Wasatch Plateau are classified as 1C, 2B, 3A, and 4. Classes 1C, 2B, 3A, 3C, and 4 designate domestic, secondary contact recreation, cold water aquatics, warm water aquatics, and agricultural uses, respectively (UDWQ, 2006).

Suspended sediment load is site specific. The suspended sediment concentrations varied in surface-water samples collected by the USGS (Danielsen and others, 1981) in Huntington and Cottonwood Canyons: data for three sites are included in Table III-5. The sample from Bear Canyon shows a high sediment concentration while Tie Fork is low relative to the other two sites presented: Danielsen and others attributed the high concentration in Bear Canyon to continuous erosion and sloughing of fine-grained sediments caused by the springs that emerge from the Blackhawk Formation in the headwaters. Suspended sediment concentrations generally increase as flows increase.

## IV. PROBABLE HYDROLOGIC IMPACTS

In this section, potential impacts to ground water and surface water associated with mining are identified. Specific ground-water and surface-water resources within the CIA are identified and data are reviewed to determine potential impacts to the hydrologic balance. Probable impacts to the hydrologic balance are then determined.

### RESOURCE HYDROLOGIC IMPACT ASSESSMENT

Quantity and quality may be affected by mining activities. Because of the semi-arid environment in Carbon and Emery Counties, potential changes in ground-water quantity seem to have been the recent focus of concern from the public. Changes in quality are discussed in conjunction with spring and surface-water uses (**Surface-Water Resource Hydrologic Impact Assessment**) because use in the region is primarily tied to the associated surface discharge points.

Mining may alter flow direction, water storage, and permeability and transmissivity. Altered flow characteristics result from intercepting adjacent water sources, from water transfer across basins, and from changes in permeability and transmissivity in rock units above, below, and within the mined rock units. Permeability and transmissivity changes may affect quantity, recharge, and transport characteristics.

Removal of the coal creates a void, increasing transmissivity and water storage. Subsidence increases pore space in overlaying strata and changes storage, permeability, and transmissivity characteristics. Mining can depressurize ground water in an underlying rock unit and lower the potentiometric surface, even if no direct interception of water occurs. Water retention time may be increased or decreased depending on the changes in storage volume and rate of water transmission. Increased flow rates and storage may result in a permanent lowering of potentiometric surfaces. Changes in residence time may affect seasonal flow patterns.

Mining and mining related subsidence may intercept water from surface-water sources, aquifers and other saturated zones, unsaturated zones, or faults and fractures. Ground water may return to its original flow path after interception or it may be redirected. Potential effects include a loss or gain in water quantity at a storage location, an increase or decrease in flow at an existing discharge point, and a newly created discharge location. Ground water is removed as moisture in the mined coal and evaporated by mine ventilation.

Quality changes may include changes in pH, TDS, nutrients, metals, salts, and other inorganic and organic constituents. Mining may alter the quality when it causes different types or sources of water to mix. Surface water may be intercepted by subsidence and mixed with ground water. Springs and aquifers above the mine may be intercepted and waters with different qualities mixed. Depending on the quality of the waters involved and the quantity or ratio of mixing, water quality may improve or degrade.

Mining activities can also change the chemistry of the system directly. Mining activities may affect the quality when mined surfaces are exposed to minerals or salts that can be transported with ground water. Weathering and oxidation can produce acid- and toxic materials. Mine rock dust generally increases TDS and may change the chemical signature of the waters. Spills, human waste, hydrocarbons, hydraulic fluids, and other chemicals used in operations may be discharged to surface and ground water.

## **GROUND-WATER INTERCEPTION**

Information about ground water in the CIA is reviewed for mines, wells, and springs. Mine-water discharge analyses are discussed in the **Surface-Water Resource Hydrologic Impact Assessment** section of this CHIA.

### **Star Point Mine**

Operations at the Star Point Mine occurred in two ground-water regions and affected a third. These regions are defined generally and some interaction between them apparently occurs. The first ground-water region is located on the east side of the Bear Canyon Fault, the second is located on the west side of the Bear Canyon Graben within Gentry Ridge Horst, and the third region is along the Trail Canyon Fault, the east boundary fault of the Pleasant Valley Graben (Map 3). The following section discusses water intercepted during mining operations: 1) east of the Bear Canyon Fault, 2) at the Bear Canyon Fault and Graben Crossing, 3) within Gentry Ridge Horst, and 4) along the Trail Canyon Fault, at the west side of the Gentry Ridge Horst - east side of the Pleasant Valley Graben, .

In general, the Star Point Mine did not discharge large volumes of water because the mine pumped and diverted the water into old workings, and the mine has also consumed some of the water intercepted. The primary diversion of ground water occurred from June 1992 to December 1997 when water was pumped from the Gentry Ridge Horst, across the Bear Canyon Graben, and into the older Third Seam workings east of the Bear Canyon Fault, mainly to Mother Goose sump in the Middle Seam. Water was also pumped to Mother Goose sump from the Wattis and Hiawatha Seams on the east side of the Bear Canyon Fault. During this pumping, decreased flows were observed at Upper Tie Fork Spring, and discharge from the Mohrland portal increased (Figure 1). Big Bear Spring and other Star Point Sandstone water sources in Huntington Canyon may have been affected, but no measurable or demonstrable impacts are evident in the data from these springs.

From June 1992 to December 1997, an average of over 500 gpm was pumped from the Gentry Ridge area of the Star Point Mine. Volume increased rapidly from 1992 until it exceeded 1,300 gpm, from December 1994 to February 1995, then even more rapidly declined to less than 100 gpm by January 1997 (Figure 1). Starting in late 1992, average discharge from the Hiawatha Mine's Mohrland Portal (UPDES 001 and 002 combined) rose until it was over 1,000 gpm in late 1994 and early 1995. (Between November 1992 and July 1995, there was no flow measured at UPDES discharge point UT0023094-002 because the water supply system for the town of Hiawatha was shutdown. Water that would have normally gone to the water tanks was

discharging through UT0023094-001 to Cedar Creek.). The flow briefly spiked at over 1,600 gpm in August 1995, but dropped quickly, and by the time pumping at Star Point ceased in 1997 the average discharge from the Mohrland Portal was similar to, and perhaps somewhat less than, what it had been before pumping started. Figure 1 shows the strong correlation between the Star Point Mine pumping and increased discharges at the Mohrland Portal. However, pumping at Star Point Mine does not account for all high Mohrland discharges, such as occurred in July 1988, May 1991, April 1992 (just before pumping began), and August 2003. So in addition to Star Point Mine pumping, there appear to be other, unidentified factors that contribute to periodic high discharges from the Hiawatha Mine.

*Star Point Mine: East of the Bear Canyon Fault*

Star Point Mine piezometers indicated that east of the Bear Canyon Fault, the saturated zone would be below the coal seams in the Star Point Sandstone. The gradient is to the south-southeast, toward Miller Creek (Star Point Mine Plan, p. 700-10).

Most water intercepted east of the Bear Canyon Fault in the Star Point Mine was pumped to sumps within the mined areas. Mother Goose sump, the main sump of the system, was located in the Main West area of the Third (middle) coal seam (Star Point Mine Plan, Map 722.100e) at roughly the same location as in-mine well P 86-01-TD (Map 3). Flow meters monitored at Mother Goose sump measured water pumped to other areas of the mine. Father, Twin and New Goose sumps were located in the Wattis Seam workings, and Baby Goose sump was near the Mudwater discharge within the Third Seam. (Star Point Mine Plan, p. 700-24).

Water discharged at the Star Point Mine Mud Water Fan (UPDES UT0023736-001) was monitored beginning February 1985: there has been no discharge from UPDES 001 since July 1987 (Star Point Mine Plan, p. 700-31).

Some water was used to supply culinary needs for the Lion Deck bathhouse and office. Monitoring of water used from within the mine for culinary purposes was initiated in February 1985. Losses from fan ventilation evaporation have not been estimated (Star Point Mine Plan, p. 700-24).

In-mine ground water was monitored at 16 locations in the Star Point Mine from April 1985 to March 1986. The Star Point Mine plan states, "the total instantaneous flow from the 16 in-mine measuring points is an indication of the majority of flow made within the mine, but does not necessarily reflect the total flow made within the mine". "...the average annual flowrate from the 16 in-mine measuring points was approximately 150 gpm from April, 1985 to March, 1986. The average annual discharge from the mine over the same period at Mud Water Canyon [Star Point UPDES 001] was 129 gpm (66,611,600 gallons over the year). The average annual discharge from the mine to the surface facilities for coal washing and surface dust control was only 0.5 gpm (267,432 gallons). The average annual discharge for culinary use was approximately 4.4 gpm (2,289,000 gallons). Therefore, the total annual discharge from the mine to the surface was 134 gpm, excluding the undetermined flow that exits the mine as water vapor in the air." (Star Point Mine Plan, p. 700-25).

The Star Point mine plan states on page 700-25, "...the flow from the long wall area No. 12 has diminished over time since its peak in September of 1985 when long wall panel No. 3 was started. In March of 1986, the flow jumped to 120 gpm: the increase in seepage was from increased pumping of recycled water from the sump areas for dust suppression in the long wall panel area". The proximity of Panel 12 to the subsided area of the North Fork of the Right Fork of Miller Creek and a fracture zone probably influenced inflow in this region (Maps 3 and 3a).

When the Star Point Mine Plan was updated in 1996 for permit renewal, 1WN6 and 9L12 were the only sites being used for in-mine monitoring. These two stations were last monitored in October 1997. There are no mine discharges from the main Star Point Mine portals or any of the fan portals in Corner Canyon and Mud Water Canyon. All portals have been sealed and backfilled, the last portal being sealed in January 2001.

Measured inflows to the mine did not necessarily include all flow into the mine. In 1991, average inflow to the workings east of the graben was estimated to be:

1985 through 1986	237 gpm	0.53 cfs
1986 through 1987	218 gpm	0.48 cfs
1988	71 gpm	0.16 cfs
1989	49 gpm	0.11 cfs
1990	37 gpm	0.08 cfs
1991	24 gpm	0.05 cfs

The 1988 to 1991 data indicate an annual decrease of 25 to 40 percent per year. Based on the area exposed by the mine workings and the rates of discharge, PMC estimated 95 percent of the water came from storage, mainly from channel sandstones in the Blackhawk Formation, and that probably less than 5 gpm came from the surface (Star Point Mine Plan, p. 700-62)

#### *Star Point Mine: Bear Canyon Fault and Bear Canyon Graben Crossing*

A rock tunnel crossing was developed through the Bear Canyon Graben in 1989 to allow access to coal under Gentry and Castle Valley Ridges. The rock tunnel crossing extended from the Wattis Coal Seam east of the Bear Canyon Graben (elevation 8,492 feet) to the Wattis Coal Seam west of the graben (elevation 8,450 feet): the Wattis Seam was the only seam mined under Gentry Ridge. The rock tunnel was in the upper Blackhawk Formation, 200 to 325 feet above the Wattis Coal Seam. In exploratory borings, the saturated zone system was confirmed to lie 45 to 160 feet below the graben tunnel. The piezometric gradient is to the south, toward Huntington Creek (Star Point Mine Plan, p. 700-10, 700-12).

Water encountered during mining east of the graben was in perched, primarily fracture-related systems in the upper Blackhawk Formation, above the saturated zone. Water flowed into the mine at the Bear Canyon Fault (the eastern boundary fault of the graben) when the 2<sup>nd</sup> Left and 2<sup>nd</sup> West Mains intercepted the fault. Initial inflow at 2<sup>nd</sup> Left was 6 gpm from roof strata on the face offset (approximate elevation 8,780 feet). Within three weeks, liquefied gouge at the faces of entries #2 and #3 flowed approximately 10 to 15 feet into the entries.

Drilling from within the #1 entry penetrated 40 to 60 feet of gouge and fractured rock before tapping into what the mine operator called a "significant" ground-water conduit (the drill hole penetrated 400 feet into the graben). Inflow from the drill holes peaked at about 150 gpm before dropping to 50 gpm after 2 weeks, to less than 10 gpm after 10 weeks, and subsequently to 0 gpm.

In the 2<sup>nd</sup> West Mains (approximate elevation 8,490 feet), PMC experienced an initial inflow rate of about 20 gpm from the roof strata. This flow reduced to less than 10 gpm after 4 weeks. Very little water was found at the actual face. Inflow to the mine at the entry to the graben tunnel at 2<sup>nd</sup> West Mains dropped rapidly during drilling, from 20 gpm to 10 gpm over a four-week period and eventually to 0 gpm, indicating the dewatering of a perched aquifer system (Star Point Mine Plan, pp. 700-11 and 700-12).

*Star Point Mine: Gentry Ridge Horst*

PMC recognized the water table under Gentry Mountain would be intercepted during mining so they entered into a mitigation agreement with NEWUA. This agreement is discussed further under the section in this CHIA entitled **Material Damage**.

Wet floor was reported along the 3<sup>rd</sup> South Mains, south of the graben tunnel entries. Flows of up to 50 gpm were reported from several specific sites along these mains. Volumes generally increased downdip, to the south.. Water seeped through the floor of the 4<sup>th</sup> and 5<sup>th</sup> Right entries, and from the roof at the west end of the 2<sup>nd</sup> and 3<sup>rd</sup> Right entries. Larger flows were generally associated with the Trail Canyon Fault, the western boundary fault for the horst, and auxiliary finger-faults and fractures. As mining continued down dip, flow rates of 50 to 250 gpm were recorded in the bleeders and set-up rooms along the west side of the mined area, near the headwaters of Wild Cattle Hollow (Star Point Mine Plan, p. 700-63; Map 728b).

Water from the Gentry Ridge area was pumped from June 1992 to December 1997 across the Bear Canyon Graben into the Third Seam workings east of the Bear Canyon Fault, mainly to Mother Goose sump. Volume increased rapidly from 1992 until it exceeded 1,300 gpm from December 1994 to February 1995, then even more rapidly declined to less than 100 gpm by January 1997 (Figure 1). Water was also pumped to Mother Goose sump from the Wattis and Hiawatha Seams.

UPDES permitted discharges from the Star Point Mine over this period were sporadic and usually low volume. However, discharges from the Mohrland Portal at the Hiawatha Mine mimicked the pumping rate from the Gentry Ridge Horst to Mother Goose sump, so it is a reasonable conclusion that most of the mine-water discharged from the Hiawatha Mine during this time originated as water pumped across the Bear Canyon Graben in the Star Point Mine. Figure 1 shows the flow rates from Hiawatha's Mohrland Portal (UPDES discharge points UT0023094-001 and -002), Big Bear Spring, Upper Tie Fork Spring, and Star Point's Gentry Ridge Horst pumping. The flows at Big Bear Spring had already declined before pumping began in 1992, and although flow rates fluctuated, there was no evident impact to this spring from the pumping. The impact at Upper Tie Fork was anticipated.

The total interbasin transfer of water pumped from the Gentry Ridge Horst to the Mother Goose sump was estimated by UDOGM. Flow rates from Upper Tie Fork Spring and flow rates monitored at the Gentry Ridge in-mine monitoring site GENTRID were used to make the estimate.

Losses at Upper Tie Fork Spring were estimated from data received on December 18, 1997 from Darrel Leamaster (CVSSD provides regular updates of these flow data. The combined flow of Upper and Lower Tie Fork is metered constantly, but separate data for the Upper and Lower springs can only be obtained on-site, so data for winter months are sometimes missing.) The following assumptions were made to obtain the estimated flow loss for 1992 to 1997:

- 1) Missing data from November 1993 through April 1994 were estimated by interpolation between the October 1993 and May 1994 flow rates;
- 2) The average monthly flow prior to dewatering was assumed to be 85 gpm (the rate observed on October 1991 prior to a recorded decrease in flow at the spring);
- 3) The dewatering period was assumed to extend into April 1996 simply because Upper Tie Fork Spring regained 85 gpm flow rate after this date.
- 4) Flow rates recorded from November 1991 through April 1996 were subtracted from 85 gpm then added together to estimate the total loss of flow at Upper Tie Fork Spring.

Using the method described above it was estimated that the total flow volume at Upper Tie Fork Spring decreased by 139.5 acre-feet (acre-ft) during the period of mining under Gentry Ridge. The estimated maximum annual loss was 58.7 acre-ft in 1995. The maximum loss to flow at Upper Tie Fork Spring occurred in May and June of 1995 and was 46 gpm (0.1cfs). A percentage of the loss can be attributed to 1987 - 1993 drought, but adjustments for climate were not assessed.

A monthly flow volume was determined and then totaled for the period when water was pumped from Gentry Ridge across the Bear Canyon Graben into the Mother Goose sump, east of the graben. Instantaneous flow rates from the Gentry Ridge monitoring station GENTRID were reported for June 1992 through December 1997. Water quantities reported to UDOGM were instantaneous readings only: no totalizing flow rates were reported. The following techniques and assumptions were made to estimate the flow volume pumped from Gentry Ridge:

1. Where there was one record per month, that value was applied to the entire month;
2. Where there was more than one record per month, the first recorded flow volume was applied from the first day of the month up to the date of that measurement, the volume of the second measurement was applied from the date of that measurement through the end of the month, and the average of the two measured flows was applied to each day between;
3. Where monthly flow values were missing, flows from the preceding and following months were averaged;
4. The pumping rate was assumed to be continuous, 24 hours per day.

Using this method the total water transported across the graben was estimated to be between 4,500 to 5,000 acre-ft.

The Star Point Mine Graben - Goose information provided to CVSSD was obtained on April 17, 1998. The data are available for June 1992 through December 1997; however, data for February, March, May, and June 1993 were unavailable because the meter was not functioning. The maximum reported instantaneous flow rate was 1,600 gpm on January 26, 1994, but the greatest average discharge was 1,398 gpm in December 1994. Based on the average monthly rate in the CVSSD data, the maximum monthly discharge volume, 143 to 146 acre-ft, occurred in March through May 1995. The maximum annual discharge was estimated to be 1,627 acre-ft in 1995.

The volume of water pumped from the Gentry Ridge Horst is much larger than the estimated loss for Upper Tie Fork Spring. When compared to the volume of water pumped from the Gentry Ridge Horst, the much smaller flow loss at Upper Tie Fork Spring indicates dewatering in the Gentry Ridge Horst drew water from a larger area than the immediate vicinity of Tie Fork Spring.

Impacts to other water sources have not been reported. The decline in flow at Bear Canyon Spring began before the Gentry Ridge Horst pumping. Flow remained fairly stable while the horst was being pumped, although there was a small drop in 1995 followed by a rise in 1996 (Figure 15). There is evidence these were responses to the 1987 – 1993 drought, but these 1995 and 1996 changes could be related to the intense pumping in 1994 and the rapid drop in pumping in 1995 (Figure 1). Likewise, the decline in flow at Birch Spring predates the Star Point pumping. A slow decline continued steadily through the pumping period, apparently unaffected by either the pumping or recovery from the drought (Figures 2 and 11).

### **Star Point Mine Well Information**

Star Point Mine wells are identified below in Tables-IV-1 and - 2 to aid in understanding the monitored formations. Graphs showing well water elevations are presented in Figures 3, 4a, 4b, and 5a. The well data are grouped within each region: East of the Bear Canyon Fault (Figure 3); Gentry Ridge, in Gentry Ridge (Figures 4a and 4b); and flows from Tie Fork Spring and related data, on or west of the Trail Canyon (Figure 5a). Locations are found on Map 5 - Gentry Mtn. Geology.

#### *East of the Bear Canyon Fault (Figure 3)*

**Table IV-1: Star Point In-Mine Monitoring Wells  
 East of the Bear Canyon Fault**

<b>Well Number</b>	<b>Depth and Formation Monitored</b>	<b>Relative Location</b>	<b>General Observations</b>
P86-01-TD	145 feet - Spring Canyon Sandstone -27 ft below the Hiawatha Seam.	East of the Bear Canyon Fault near the Mother Goose Graben.	Increase of 45 ft of head since 1993. Abandoned 1998.
P86-02-HD Btm - 8402 ft	71 feet - Spring Canyon Sandstone - screened below the Hiawatha (screen interval 50 ft)	East of the Bear Canyon Fault on west side of Hoag Ridge.	Water level was always at or below the lowest well perforations - 8463 to 8413 feet. Abandoned 1998.
P86-03-WD	194 feet - Blackhawk screened below the floor of the Third Seam (screen interval 43.5 feet)	East of the Bear Canyon Fault on the west side of Hoag Ridge south of 86-02-HD and mining section 8 sumps.	Water level showed a small decline of 20 feet, 8,320 to 8,300 feet, with a few temporary drops that could have been due to climate, localized de-watering and mine-water routing, depressurizing from mining, subsidence, or measuring error (Drops occurred in Nov. 86, July 87, Mar 91, July 93). Abandoned 1997.

Well P86-01-TD, 86-02-HD, and P86-03-WD were in-mine wells. They were abandoned in late 1997 to mid 1998 because the area of the mine where they were located was sealed. P86-01-TD, developed in the Spring Canyon Sandstone and located on the East Side of the Bear Canyon Fault and Graben, increased in head during early 1994 when pumping rates from Gentry Ridge peaked. This well was located south of the sumps located near the North Fork of Miller Creek. Well 86-02-HD was also developed in the Spring Canyon Sandstone. Water level was at or below the lowest screened elevation since it was developed. Well P86-03-WD, in the Blackhawk Formation below the Third Seam, showed a decreasing trend since it was first developed in 1986 and probably represented dewatering from mining in the Hiawatha Seam.

*Gentry Ridge: West of the Bear Canyon Fault (Figures 4a, 4b, 5a, and 5b)*

Star Point Mine workings in the Wattis Seam in the Gentry Ridge Horst penetrated over 200 feet below the Blackhawk – Star Point potentiometric surface. Large volumes of water were pumped from the Gentry Ridge Horst workings as mining progressed downdip in the Wattis Seam. Maximum monthly discharge volume was approximately 145 acre-ft in early 1995, and the estimated discharge for 1995 was 1,600 acre-ft. This pumping affected the potentiometric surface in the Gentry Ridge Horst (Figures 4a and 4b) and possibly in the McCadden Hollow area (Figure 5b), and flow at Upper Tie Fork Spring (Figure 5a).

The three Star Point Sandstone tongues are seen at outcrop exposures at Bear Canyon and north and south of the CIA, but exposures of the Star Point to the west are massive sandstone with no shale. Boreholes in the Star Point Mine area did not penetrate the entire Star Point Sandstone, so it is not certain that three distinct sandstone tongues are present there, although that is how they have been depicted (Bear Canyon Mine Plan, Plates 7J-1 and J-2). The pumping affected all saturated strata in the Gentry Ridge Horst, but the varying responses show that the

Spring Canyon Sandstone Member and Blackhawk Formation, even though they might be hydrologically interconnected along faults and fractures, are not a homogeneous aquifer.

P92-10-1, drilled from the surface, was located between the Gentry Ridge Horst mine workings and Nuck Woodward Creek. The single measurement (Figure 4a) from the Star Point Sandstone indicates the gradient is higher to the north, apparently recharged in Nuck Woodward Canyon.

P93-01-WD was located in the northern Gentry Ridge mine workings. It was drilled to the Spring Canyon Sandstone Member in 1993, after pumping from the south end of the mine had started. The well was only screened over a 1-ft interval, and after a reported initial 9-ft drop in water level, the well went dry in 1995.

<b>West of the Bear Canyon Fault</b>			
<b>Well Number</b> Period of Record Collar Elevation Bottom of Well	<b>Formation Monitored</b>	<b>Relative Location</b>	<b>General Observations</b>
P-92-10-1 1993 C.E. - Btm - -	Star Point Sandstone One point of data.	Surface well, ~1 mile from Nuck Woodward channel. Completed in the Gentry Ridge Horst near the west end of the 4 <sup>th</sup> West Mains, but it did not intercept the mine workings.	The water elevation at the initial and only reading possibly indicated recharge from Nuck Woodward Canyon.
P93-01-WD 1993-1995 C.E. - Btm -	Star Point Sandstone This well has a screened interval of 1 ft.	In-mine well in the Gentry Ridge Horst, in the 3 <sup>rd</sup> North Mains, north of 92-01-A(B,C)-WD.	The water level dropped below the top of the screened interval and went dry in 1995.
P-92-01-A-WD* 1992-1997 C.E. - 8364.5* Btm - 8291.5 ft	Blackhawk- screened 61 feet below floor of Wattis Seam (screen interval 8301.5 - 8291.5)	In-mine well nested with P-92-01-B and C. In the Gentry Ridge Horst, at the east end of 3 <sup>rd</sup> West Mains, near the exit of the graben tunnel.	Water level dropped about 30 ft and did not recover appreciably during the monitoring period.
P-92-01-B-WD* 1992-1997 C.E. - 8364.5* Btm - 8248 ft	Blackhawk- screened 104.5 feet below floor of Wattis Seam (screen interval 8258 - 8248)	In-mine well nested with P-92-01-A and C.	Water level dropped about 46 ft by 1995 and did not recover appreciably during the monitoring period. Two anomalous drops in 10/93 and 10/94.
P-92-01C-WD* 1992-1997 C.E. - 8363.9* Btm - 8171.5 ft	Star Point Sandstone - screened 45.7 feet below the Hiawatha (screen interval 8186.5 - 8171.5)	In-mine well nested with P-92-01-A and B.	Water level dropped 108 ft by 1995, recovered to 68 ft below initial level by the time monitoring ended.
P-92-02-WD 1992-1997 C.E. - 8362.24 Btm - 8156.2 ft	Star Point Sandstone -screened 54.5 feet below the Hiawatha (screen interval 8171.2 - 8156.2)	In-mine well in the Gentry Ridge Horst, at the west end of 3 <sup>rd</sup> West Mains.	Water level dropped 126 ft by 1995, recovered to 79 ft below initial level by the time monitoring ended.
P-92-04-WD 1992-1997 C.E. - 8363.0 Btm - 8193	Star Point Sandstone -screened 27 feet below the Hiawatha (screen interval 8204 - 8189)	In-mine well in the Gentry Ridge Horst, center of the 3 <sup>rd</sup> West Mains, between 92-01-A(B,C)-WD and 92-02-WD.	Water level dropped 154 feet by 1995, recovered to 115 ft below initial level by the time monitoring ended.

P-92-03-WD 1992-1996 Btm = 8237.4	Blackhawk- screened 32.5 feet below floor of Wattis Seam (screen interval 10.5 ft)	In-mine well in the Gentry Ridge Horst. In the 3 <sup>rd</sup> South Mains, south of 92-01-A(B,C)-WD.	This was a flowing in-mine well. The potentiometric surface was 8,322 feet in 1992. It had dropped 70 ft as of 1996, the last measurement.
86-26-6 1994-1997 C.E. - Btm -	Star Point Sandstone	Surface well on the ridge between Wild Cattle Hollow and Gentry Mountain, ~1/2 mile south of the mine workings. Completed in the Gentry Ridge Horst,	Water level decreased 35 feet in the fall of 1995 but had increased to 74 feet above the first recorded elevation as of July 1997.
86-35-2-3; 86-35-2 and 86-35-3 1986 - present Btm =	Star Point Sandstone	Upper Tie Fork Spring, located west of the Pleasant Valley Fault. Two sources, ~200 ft apart.	Two seismic exploration shot holes that had artesian flow. Developed by CVSSD - Huntington City as Upper Tie Fork Spring. Head dropped during pumping from the Gentry Ridge Horst but has since recovered.
85-35-1 1988-1997 C.E. - Btm -	Star Point Sandstone	Formerly part of Upper Tie Fork Spring, located east of 85-35-2-3 and east of the Trail Canyon Fault.	CPM coal-exploration borehole that had artesian flow. Added to Upper Tie Fork Spring system in 1988, it stopped flowing about a year later and was removed from the system.

\*P92-01A-WD, P92-01B-WD and P92-01C-WD are nested wells. Collar elevations vary slightly because of individual casings.

P92-03-WD, P92-01A-WD, and P92-01B-WD, in-mine wells completed in the Blackhawk Formation, also decreased in head during mining (Figures 4a and 4b). The most notable decrease was at well P92-03-WD, which began as a flowing well when it was developed in March 1992. The water level dropped 35 ft even before pumping began, and dropped another 35 ft during mine dewatering. P92-01A-WD, screened approximately 50 feet above the Hiawatha Seam, and P92-01B-WD, screened approximately 10 feet above the Hiawatha Seam, are nested wells located near the middle of the Gentry Ridge workings. Pumping produced an immediate drop in water levels in both. Water levels dropped a few more feet as pumping increased up to 1995. Water elevations were the same in these two piezometers when first measured, but levels dropped about 15 ft more in the deeper well as pumping continued, showing that even though they may be interconnected, the Blackhawk strata are not a homogeneous aquifer or hydrologic system. At the time monitoring stopped in December 1997, water elevation at P92-01A WD had recovered to 30 ft below the initial elevation and P92-01B-WD had recovered to 43 feet below the initial elevation (Figure 4b).

P92-01C-WD, screened approximately 50 feet below the Hiawatha Seam in the Spring Canyon Sandstone, dropped 108 ft, and then began to recover as soon as the pumping rate declined in 1996. At the time monitoring stopped in December 1997, water elevation had recovered to 68 ft below the initial elevation (Figure 4b). The other two in-mine wells completed in the Spring Canyon Sandstone, P92-02-WD and P92-04-WD showed similar responses to the pumping.

Well 86-26-6, developed in the Spring Canyon Tongue of the Star Point Sandstone, responded in a pattern similar to Upper Tie Fork Springs (Figure 5a). Pumping from the mine

workings lowered the potentiometric surface 35 ft, to a minimum elevation of 8,094 ft in August 1995. The water level was rising in 1996 as pumping rates declined (Figures 4a and 4b). Water levels were measured using gas pressure, and measurements after September 1997 in 86-26-6 are not valid because the gas line was partially blocked.

Upper Tie Fork has been discharging above the pre-earthquake flow rate since late 1996 (Figure 5). Both the earthquake and the mining activities affected the flow. Changes in the recharge area, porosity, and transmissivity are possible mining-related factors that increased flow at the Upper Tie Fork Spring. (The cause of the precipitous drop in 2002 is not known.) The wells that lie farther north and to the center of the graben may never recover to their initial elevation except during extremely wet climatic periods because there is increased storage capacity (porosity) in the mined region: the volume of water inflow, outflow, and storage is the same but there is more void space to fill.

### **Bear Canyon Mine Interception**

Bear Canyon Mines #1 and #2 are located in the Bear Canyon Graben. Flows have primarily entered the #1 and #2 Mines through fractures and channel sandstones. Some water was observed from roof bolts and from the mine floor. Flows from faults and fractures were stated to produce the largest volume of water flowing into the mine during the early mining periods, but the Bear Canyon Fault, the major boundary fault, has yielded only minor amounts of water. Flows from roof bolts in the ceiling typically flowed moderately for one or two months and then eventually de-water (Attachment to Appendix 7-J, Bear Canyon Mine Plan). Water intercepted during mining primarily occurred in the Blind Canyon Seam and not in the overlying Tank or underlying Hiawatha Seams.

#### *Hiawatha Seam*

Plate 7-10B of the Bear Canyon Mine Plan shows the areas where water was encountered in the Hiawatha level of Mine #1. Only three areas are identified, and only small flow volumes were reported. One was a roof drip of less than 0.1 gpm in the northwest area of the mine.

Water seeped at under 1 gpm from a rib where the main entries crossed a fault. The fault, with 5 feet of down-to-the-west offset, is probably part of the Bear Canyon Fault system. The flow lasted for a few months.

In the northwestern corner of the Hiawatha workings, where the Hiawatha Seam entries approached but did not intercept the Blind Canyon Fault, water seeped through the floor at 4 gpm. A few months after the flow was encountered, the area was sealed because of a roof fall, so duration of flow is unknown (Personal communication, Mark Reynolds, February 21, 2007).

Holes drilled nearby drain water from the Blind Canyon level down to the Hiawatha level, and the combined flow from the Hiawatha and Blind Canyon workings provides the water supply for the Bear Canyon Mine. The water-supply line passes through the seal in the #1 Mine portal, and the water is monitored at SBC-9A. Flow from September 2002 to August 2006 averaged 28 gpm.

### *Blind Canyon Seam*

The majority of ground water intercepted in the Bear Canyon Mine has come from the Blind Canyon Seam channel sandstone, which was deposited in a channel eroded into the coal deposits. Many similar sandstone channels encountered in coal mines are discontinuous, but this sand channel spans the mined area and appears to extend from the Blind Canyon Fault to the Bear Canyon Fault (Map 4). In August 1989, mining operations in the North Mains in the #1 Mine approached the margins of the channel sandstone in the mine roof. By November 1989, large roof drips began to flow into the mine in this area. Initial flows measured in February 1990 at SBC-9 were 120 gpm, and flows reached a maximum of 175 gpm in 1993 - 1994 (Figure 6).

In January 1992, monitoring began at SBC-10 in the 1<sup>st</sup> East entries: flow started at 250 gpm, and combined flow measured at SBC-9 and SBC-10 in February was 382 gpm. Mining in the North Mains reached the main body of the sandstone April 27, 1993, and SBC-9 was moved closer to the channel sandstone. Flows rapidly declined at SBC-10, dropping to approximately 25 gpm by 1994. SBC-10 became inaccessible in 1995. Flow at SBC-9 declined gradually from 1995 to 1999 and was 55 gpm October 1999, just before the area was sealed in November 1999. In 1997, water that is believed to be from the SBC-10 area began discharging from the gob at SBC-13. When monitoring ceased in February 2002, flow was averaging approximately 28 gpm and appeared to be slowly declining. In 2002, a hole was bored up from the Hiawatha level to drain the Blind Canyon workings, and the flow down the hole was monitored at SBC-9A. Water entered a pipe nearby and was carried out of the mine to storage tanks, and this water provides the culinary and process water supply for the Bear Canyon Mine. A roof fall in 2003 made SBC-9A inaccessible, but the water line remained intact. The water line was shielded to protect against further damage from roof falls, and the #1 and #2 Mine portals were sealed in 2003 - 2004. The combined discharge from the Blind Canyon and Hiawatha workings of the Bear Canyon #1 Mine is piped through the seal and continues to provide the water supply for the Bear Canyon Mine. Monitoring point SBC-9A was relocated to outside the mine, to a valve on the water line (Figure 6).

Water users have postulated that water discharging from the channel sandstone was previously recharging Birch Spring; the details associated with Birch Spring flows are discussed in the Resource Hydrologic Impact Assessment section.

When mining began in the Blind Canyon Seam, the first inflows were identified as coming from the floor in the Second East Entry and it was thought that this water originated from the Spring Canyon Tongue. Initial hydrologic evaluations from the Bear Canyon Mine Plan, Appendix 7-N (April 16, 1993) described the mine as intercepting the potentiometric surface of the Spring Canyon Tongue in the north ends of the North Main and Second East entries. It is now believed that this water originated from the Blind Canyon channel sandstone.

Before inflow from the Blind Canyon channel sandstone was encountered, water draining from faults and fractures produced the largest volumes flowing into the mine. Prior to the start of mining operations by Co-Op Mining in 1982, water flowed to old, abandoned workings. When Co-Op developed the East Bleeders fault crossing (NE/4NE/4, Section 23) flow to the abandoned

workings ceased, and flow from the faults was approximately the same as what had previously flowed to the old workings. "Inflow to the East Bleeders continued until the summer of 1989, when water was encountered as the North Main entries were advanced northward. According to Wendell Owen, inflow to the East Bleeders gradually diminished and flow into the North Mains was approximately 110 gpm" (Bear Canyon Mine Plan, Appendix 7-N).

Initial mining in the Wild Horse Ridge area was in the Tank Seam, with a rock tunnel down to the Blind Canyon Seam and breakout of the Blind Canyon portals from inside. The Wild Horse Ridge workings are separated from the Bear Canyon #1 Mine workings, where the Blind Canyon Seam was very wet due mainly to the large channel sandstone, by the Bear Canyon Fault. Mining projection maps (Bear Canyon Mine Plan, Map 5-1A) show Wild Horse Ridge workings will remain several hundred feet east of this fault: Bear Canyon has been eroded along this fault and the Blind Canyon Seam crops out between the Wild Horse Ridge mines and the fault. There are also large sections of burned coal along the outcrop. If water is present in the Bear Canyon Fault, mining the Blind Canyon Seam under Wild Horse Ridge should not cause interference with its flow.

On March 22, 2000 a Division Order required Co-Op Mining to modify the permit application by including "a minimum of one in-mine drill hole located in the northern portion of the Wild Horse Ridge Addition." That requirement was complied with by addition of plans for monitoring well DH-5, which will be located at the northern boundary of the Wild Horse Ridge mine extension and central to the combined Wild Horse Ridge and Mohrland extensions.. The drill hole will be tested using the same methodology that was used in the previous in-mine wells, as described in Appendix 7-N of the Bear Canyon Mine Plan.

### *Tank Seam*

At the Bear Canyon #1 Mine, Co-Op Mining Company drilled eight exploratory drill holes up into the Tank Seam from the Blind Canyon Seam (p. 7-23; Plate 6-1; Appendix 6-A, Bear Canyon Mine Plan). All were essentially dry except T-13 (no drillers log), where initial flow was 0.5 gpm and declined to approximately 0.1 gpm by 1997. Stratigraphically, the Tank Seam is 250 feet above the Blind Canyon Seam and approximately 8 to 10 gpm of water has been pumped from the Blind Canyon Seam workings into the Tank Seam for mining operations.

Initial mining in the Wild Horse Ridge area will be in the Tank Seam. This seam has proven to be basically dry in the adjacent Bear Canyon workings, which are separated from the Wild Horse Ridge workings by the Bear Canyon Fault. Mining projection maps (Bear Canyon Mine Plan Map 5-1C) show the workings will remain several hundred feet east of this fault: Bear Canyon has been eroded along this fault and the Tank Seam crops out between the planned mine and the Bear Canyon Fault, and there are also large sections of burned coal along the outcrop. If water is present in the Bear Canyon Fault, mining the Tank Seam under Wild Horse Ridge should not cause interference with its flow.

### **Bear Canyon Mine Well Information**

Wells that have been monitored at the Bear Canyon Mine include: DH-1A, DH-2, DH-3,

DH-4, SDH-1, SDH-2, SDH-3, MW-114, MW-116, and MW-117. Locations are shown on Maps 4 and 5.

Co-Op drilled in-mine bore holes DH-1A, DH-2, and DH-3 to the Mancos Shale. As each sandstone member of the Star Point Sandstone was encountered, the static water level was measured, then the sandstone member was isolated between the underlying shale and a packer and a slug test was conducted. Finally, the holes were plugged-back and developed as monitoring wells in the Spring Canyon Member. DH-1A, DH-2, and DH-3 were drilled in late 1991 and early 1992. DH-3 became inaccessible and was abandoned in November 1993. Replacement well DH-4 was drilled to and completed in the Spring Canyon Sandstone Member in January 1994. Retreat mining made all these wells inaccessible by 2002 (Figure 7).

In 1995, SDH-1, SDH-2 and SDH-3 were drilled from the surface and completed in the Spring Canyon Tongue. SDH-1 and SDH-2 were located to monitor, in conjunction with the DH series of wells, the potentiometric surface in the block between the Bear Canyon and Blind Canyon Faults. SDH-1 plugged and was lost in 1996. SDH-3 was installed west of the Blind Canyon, Dry Canyon, and Trail Canyon Faults in order to observe the effect of the faults on ground water in the Spring Canyon Sandstone. Well SDH-3 is separated from Bear Canyon by the Blind Canyon and Trail Canyon Faults. Little other information on the hydrology of this area is available.

PMC drill holes MW-114, MW-116, and MW-117 lie east of the Bear Canyon Fault. They were developed in the Spring Canyon member of the Starpoint Sandstone, in 1991. ; T-1, -2, -4, and -5, drilled by Savage Energy Services Corporation in the McCadden Hollow area in 1981 for Norwest Coal, provide additional insight into water levels in the Spring Canyon Sandstone Member. Drillers log information, including water levels, is summarized on Plate 7-9 in the Bear Canyon Mine Plan.

Based on information from these boreholes, potentiometric surfaces for the Spring Canyon, Storrs, and Panther Canyon sandstones were plotted. These cross-sections and potentiometric surface maps are shown on Plates 7J-1 and 7J-2 and 7N-3, 7N-4, and 7N-5 of the Bear Canyon Mine Plan. As measured in DH-1A, DH-2, and DH-3, the gradient of the potentiometric surface of the Spring Canyon Member (0.04 ft/ft) is to the south. That of the Storrs (0.04 ft/ft) is to the southeast, and in the Panther Member the gradient of the potentiometric surface (0.05 ft/ft) is to the south-southeast, intermediate between the directions in the two shallower members.

No additional wells have been drilled for the Wild Horse, Cedar Creek, McCadden Hollow areas, but Co-Op has committed to drill at least one additional in-mine well, DH-5, from the Tank Seam entries, to monitor the Spring Canyon Tongue. Projected location is in the NW/4, Section 19, T. 16 S., R. 8 E.

Hydraulic conductivities from the three sandstone members of the Star Point Sandstone were obtained from slug injection tests in DH-1A, DH-2, DH-3, and DH-4. A loss of drilling fluid in the Panther Tongue, below 410 feet, suggested DH-1 may have intercepted a fracture. DH-2 had a quick displacement of water and a hydraulic conductivity equal to 0.054 ft/min in the

Storrs Sandstone, but field checks indicated that the bladder had not sealed and allowed water to flow around the packer during the test. These tests found the three sandstone members had separate, distinct static water levels. Potentiometric gradients vary between the three members. None of the members was fully saturated in DH-3, the southernmost of the holes, and the Spring Canyon and Panther were not fully saturated at DH-1A (Bear Canyon Mine Plan, Appendix 7-N, Section 4.0). Variations in the chemistry of waters from the Defa #1 Spring in the Storrs Member and the Defa #2 Spring in the Panther Member also indicate the sandstone members of the Star Point Sandstone contain distinct hydrologic systems.

Following recovery from the slug tests, the first notable change at DH-1A and DH-2 occurred in 1995: a ten-foot increase in head was recorded on July 13, 1995 at DH-2 (Figure 7), and water levels recorded at DH-1A, the well closest to DH-2, showed approximately a three-foot increase. These were short-lived increases and levels dropped back down within the year. It is possible that these were measurement errors, or are the result of in-mine sumping operations; however, May 1995 saw the highest recorded flow at Lower Tie Fork Spring and flow reportedly jumped to 386 gpm at Star Point well 85-35-1 in June 1995 (Figure 5). These correspond with minimum flow (39 gpm) at Upper Tie Fork Spring in May and June 1995, and closely follow the maximum pumping from Gentry Ridge Horst in December 1994. TDS began to increase at 85-35-1 at the time of these events, rising from a pre-1995 average of approximately 350 mg/L to 562 mg/L in September 2001, when PMC stopped monitoring; both sulfate and Ca concentrations rose. TDS and sulfate increased at DH-1A at this time also, while Ca concentration dropped; however, by 1999, TDS, sulfate, and Ca had returned to pre-1995 levels. Both TDS and sulfate may have increased slightly at Upper Tie Fork Spring (86-35-2-3), but the change was not large and pre-1995 data are scattered, so the increases are within the range of pre-1995 values; also, Ca concentrations remained unchanged from pre-1995 levels. Water-quality data were not obtained at DH-2 during this period. No increased flow from the Blind Canyon channel sandstone was recorded during this period (Figure 6). The timing of these changes in water-quality and flow or water-level during May, June, and July 1995 suggest fracture-flow in the region between the Star Point and Bear Canyon Mines. This corresponds with the Shattered Zone mapped by the USGS (Brown and others, 1987) where the Pleasant Valley and Bear Canyon Grabens converge (Map 5).

The second notable change at DH-2 occurred soon after the 1995 spike. Water level dropped approximately three ft in 1996, followed by a further 12-ft drop during 1997 and 1998 (Figure 7). During 1999, the last year monitored, elevations yo-yoed over a 12-foot range. This erratic behavior in DH-2 may indicate direct connection through fractures with the surface, or with areas being actively impacted by mining. Except for the high in 1995 that was discussed previously, DH-1A showed a steady increase from mid-1992 through 1997. These changes occurred in the Spring Canyon Member, which is directly under the Hiawatha Seam (Bear Canyon Mine Plan, Plate 7J-1).

SDH-2 is approximately one mile north of the northernmost Bear Canyon Mine workings in the Blind Canyon and Tank Seams, and centered in a block of coal outlined in the projected mine plan. There is no mining planned for the Tank Seam in the McCadden Hollow area, but there is a possibility that the Blind Canyon Seam will eventually be mined there. The Spring Canyon potentiometric surface is higher at SDH-2 than it is to the south at SDH-1 and the DH

series of boreholes: the water level at in-mine well DH-4, located near the northernmost extent of mining in the Blind Canyon Seam, is approximately 275 feet below the Tank Seam and 60 feet below the Blind Canyon Seam. The potentiometric surface is higher at SDH-2 than in MW-117 to the east, across the Bear Canyon Fault (Bear Canyon Mine Plan, Plates 7J-1 and 7J-2), and higher at SDH-2 than in SDH-3 to the west, across the Dry Canyon and Trail Canyon Faults. The elevation of the potentiometric surface at the Tie Fork Springs, located approximately one mile to the northwest and across the Dry Canyon Fault, has not been measured, but these are flowing boreholes and the surface elevation at Upper Tie Fork Spring (86-35-2-3 on Map 5) is 8,010 feet. Therefore, the potentiometric surface at SDH-2 is apparently lower than at Tie Fork Springs.

As indicated on Plates 7J-1 and 7J-2 in the Bear Canyon Mine Plan, the Spring Canyon potentiometric surface is above the Tank Seam at SDH-2. The water elevation at SDH-2 was 7,964 feet in August 1994 when the well was developed. The observed water elevation at SDH-2 was 7,975.8 feet on September 02, 1997, an increase in elevation of 11.8 feet since the initial well development, and has been as high as 8,007 feet (June 21, 2000). The latest elevation, September 26, 2006, was 7,952.32 ft. The water elevation changes at SDH-2 may be the result of climatic variation, residual effects from the pumping conducted at the Star Point Mine, or both.

Water levels in SDH-2 and SDH-3 appear to roughly correlate with flow rates at Upper Tie Fork Spring (Figure 5a), but more observations are needed to conclusively determine a relationship. Currently, there is no explanation for these abrupt changes. There is no evident relationship to mining operations: the only mining activity in the area after 2001 was pillar pulling in the Bear Canyon Mine, which ceased in 2004 and did not produce any notable change in mine water discharge (Figure 6).

### **Hiawatha Mine Interception**

The Hiawatha Mine had an extensive mining history prior to the enactment of SMCRA, therefore, a lot of information on mining from this period is unknown. Available information from references in the Star Point and Hiawatha Mine Plans are included.

The Middle Fork Mine complex includes parts of the old Hiawatha No. 1 and No. 2 Mines that were closed in 1928. The No. 2 Mine was used as a water storage reservoir that was constructed by sealing off the mine entries with reinforced concrete bulkheads. According to the mine plan, the bulkheads in the No. 2 Mine have been opened and the reservoir drained but the date it was drained is not presented. This reservoir contained about 60 million gallons (184 acre-feet) on average (Hiawatha Mine Plan).

The Mohrland Mine portal has been sealed, but mine water still discharges into Cedar Creek through a bypass system. This water was previously piped to the town of Hiawatha. UDOGM's records indicate that U.S. Fuel Company (now Hiawatha Coal Company) has been discharging mine water from Mohrland Portal from February 1979 to present. The mine discharge enters a diversion box containing a weir and a valve controlled supply pipe. The valve operates the amount of water that is diverted into a steel pipe that transmits it to the town of Hiawatha in Miller Creek (UPDES 002). The current practice to obtain the UPDES discharge

rates for 001 and 002 is to measure the overflow of the weir, which goes to Cedar Creek, (001), shut the valve to the pipe flowing to Hiawatha, then take a second measurement of the weir flow. The difference is the flow to Hiawatha, (002). The flow represents all inflow from the three mined coal seams.

The water supply for the town of Hiawatha has been piped from the Mohrland Portal to water-storage tanks near the town. Hiawatha UPDES 001 monitors water discharged directly at the Hiawatha Mohrland Mine Portal. UPDES 002, in the past, measured overflow from the water tanks, so except for what is consumed from the water system, the combined flow from UPDES 001 and UPDES 002 represents the total discharge from the Mohrland portal. Prior to the pumping at the Star Point Mine, the average combined discharge from UPDES 001 and UPDES 002 was approximately 500 gpm. During the Star Point pumping, average discharge rose to almost 650 gpm; however, as can be seen on Figure 1, values fluctuated widely both before and during the Star Point pumping. By the time pumping ceased in December 1997, mining by U.S. Fuel had ended; the discharge became more consistent and the average dropped to 400 gpm. (Between November 1992 and July 1995, there was no flow measured at UPDES 002 because the water supply system was shutdown. Water that would have normally gone to the water tanks was discharging through UPDES 001 to Cedar Creek.)

As indicated on page VII-3 of section 7.1 of the Hiawatha Mine Plan (September 1986), "large water flows have been encountered in the past, mainly due to contact with the Bear Canyon Fault, which is a major water bearing structure. Old mine workings have contacted the fault at several points and this probably accounts for most of the mine water presently being discharged from the Mohrland portal". The major contact was in the 10th West Section in the King IV Mine in the 1970's. Mining was advancing in the B Seam, which is stratigraphically equivalent to the Blind Canyon Seam, when the Bear Canyon Fault was intercepted (Map 3c). Information in the Star Point Mine Plan indicates that the 10th West inflow was approximately 6,600 feet south of the Star Point Mine graben crossing, at an elevation of 8,180 feet. Inflows were as great as 100 gpm. Plate 7-22 of the Hiawatha Mine Plan illustrates the 10th West inflow location, along with other main points of mine water inflow.

Flows were encountered in the Star Point Mine before the graben crossing and mining in the Gentry Ridge Horst. According to a memorandum prepared by John Mercier of PMC, dated May 23, 1983 (Star Point Mine Plan, page 700-11):

The 2nd Left encounter (in the Star Point Mine) initially experienced little water inflow (at 6 gpm) from roof strata on the face offset. Within three weeks, liquefied gouge in the faces of entries #2 and #3 flowed approximately 10 to 15 feet into the entries. Underground drilling in the #1 entry penetrated 40 to 60 feet of gouge and fractured rock before tapping into a significant conduit. Inflow peaked at about 150 gpm from drill holes before dropping to less than 10 gpm after 10 weeks (the flow dropped to 50 gpm in two weeks). Inflow from the drill hole that penetrated the fault at the 2<sup>nd</sup> Left encounter has since dropped to zero.

A second encounter with the east side of the graben (in the 2nd West Mains)

experienced an initial inflow rate of about 20 gpm from the roof strata. This flow was reduced to less than 10 gpm after 4 weeks of exposure. Very little water has been found at the actual face offset.

The elevation at the 2<sup>nd</sup> Left encounter was approximately 8,780 feet, and at the 2<sup>nd</sup> West Mains was 8,490. Because these flows did not persist and had limited volume, they appear to be from limited, perched systems in the upper Blackhawk Formation, and were perhaps fracture-related.

The Star Point Mine Plan states on page 700-12, that the King 4 Mine lies below the regional water table. The ground water encountered in the 10<sup>th</sup> West came primarily from the floor through an area the size of a bushel basket. The fault was not penetrated; therefore, water encountered within the mine is bounded on the west by the fault system gouge zone and presumably receives recharge from areas east of the fault. No dates were presented to identify when water was intercepted.

The Hiawatha Mine presently is not mining. However, Hiawatha Coal Company, Inc. became the operator in 1998 and it is expected that mining will resume under Hiawatha Coal Company's direction in the near future.

Even though the saturated zone is beneath the coal seams, Bear Canyon Mine piezometers indicate the potentiometric surfaces will be above the Hiawatha working as they advance to the northwest and approach the Bear Canyon Fault. There is a potential for water to up well from the Star Point sandstones in this area, mainly the Spring Canyon Member.

Otherwise, inflows were The Bear Canyon #1 and #2 workings were west of the Bear Canyon Fault, and only a few entries mined up to the fault: except for the large Blind Canyon Seam channel sandstone, typical inflows were less than 5 gpm and dried up shortly after initial encounter. Inflows in areas east of the Bear Canyon Fault are expected to be on the order of a few gpm because and dry up shortly after being encountered. Except where it might be crossed to access the block of coal under McCadden Hollow, the Bear Canyon Fault will not be intercepted by the proposed mining.

#### **Hiawatha Mine Ground-water Well Information**

No ground-water information is available from wells at the Hiawatha Mine. Drill hole logs from the Hiawatha Mine were used to construct the cross-section of Gentry Mountain on Plate 7-23 of the Hiawatha Mine plan. The potentiometric data on Plate 7-23, in the southern part of Gentry Mountain, come from Bear Canyon Mine wells. It is anticipated that when the Hiawatha Mine is reopened, more ground-water information will be obtained.

#### **Trail Canyon Mine Ground-water Interception**

Water discharging from abandoned portals at monitoring sites PS-1 and CS-1 originates from old mine workings in the Hiawatha Seam. Information from these sites is the only information on underground water from the Trail Canyon Mine area. There is no information

available on water intercepted during mining.

CS-1 discharges ground water from the Community Mine (inactive in 1921) developed in the Hiawatha Seam, but the water originates from the Star Point aquifer along the Pleasant Valley Fault. Water in this mine was developed for culinary use by Trail Canyon residents in the 1960's and is in compliance with the drinking water standards (Trail Canyon Mine Bond Release Application Addendum, December 28, 1995). CS-1 is located on the west side of Trail Canyon, beyond the west edge of the former Trail Canyon Permit Area Boundary. According to information in the Trail Canyon Mine Plan, the Trail Canyon Mine workings are hydrologically separated from CS-1 by the Trail Canyon Fault.

PS-1 is located on the east side of Trail Canyon in the Hiawatha Seam and was associated with the Freed Mines (operated from mid-1920's to 1936). Since 1970, water has been pumped from the Community Mine (CS-1) to the Freed portal, and the Freed Mine is used as a culinary water storage reservoir. The portals to the Freed Mine were sealed in 1991 by UDOGM's Abandoned Mined Land Program, but use as a reservoir was maintained. When culinary water is not being pumped into the reservoir from CS-1, no flow occurs from PS-1. This suggests little or no inflow occurs into PS-1, and indicates the piezometric surface of the Star Point/Blackhawk is below PS-1 and below the Trail Canyon Mine (Trail Canyon Mine Bond Release Application Addendum, December 28, 1995).

The Trail Canyon Mine was developed from 1938 through the 1980's, on the east side of Trail Canyon in the Blind Canyon Seam. The mine workings were relatively dry. Water would have to fill the Trail Canyon Mine workings to the north, 100 feet above the mine portals, to filter through to PS-1. No discharge has been observed from the closed portals associated with the Trail Canyon Blind Canyon Seam, indicating the workings are not flooded to that point (Trail Canyon Mine Bond Release Application Addendum, December 28, 1995).

#### **Trail Canyon Mine Ground-water Well Information**

No well information is available for the Trail Canyon Mine.

#### **Burma Pond – Groundwater Impact**

The Burma evaporation basin/landfill site is a surface facility so no groundwater interception is ever anticipated. In addition, the site is lined to prevent liquids from infiltrating to the groundwater. Last, the facility has been designed for total containment of the impacted area surface water and precipitation so no liquids will run offsite and infiltrate to groundwater or impact surface water offsite. With no potential infiltration or runoff from the site no potential hydrologic impacts to groundwater or surface water exist.

#### **POTENTIAL HYDROLOGIC IMPACTS TO SPRINGS**

Spring resources with a water-quality or water-quantity change noted over the mining period are presented in the mining and reclamation plans and the data are discussed in the following sections. The potential for noted hydrologic changes at these water resources are

reviewed in relation to mining activities. Spring resources are categorically discussed on the basis of use: domestic or wildlife and agricultural.

Spring SBC-14 (WHR6) is in a small sheltered area in the bottom of the drainage, adjacent to the proposed road to the Wild Horse Ridge portals. Despite steady flow (0.5 to 15 gpm measured from 1993 to 1997), there are no water rights issued on the water flowing from this spring. However, special care is to be taken during blasting and construction in this area to preserve not only this water source, but also the pristine characteristics that make the area around this spring unique.

### **Spring Sources with Domestic Uses**

Tie Fork, Birch, and Big Bear Springs are the major ground-water resources in the CIA. Flow characteristics for these springs are presented in Figures 1, 2, 5, 8, 11a, 11b, 14a, 14b, 15, and 16a. Select water-quality data are summarized in Figures 9a, 9b, 10, 16a, and 16b in Appendix A. For information on associated water rights, see the discussion under HYDROLOGIC RESOURCES, Rights.

Fractures and faults that align with these springs extend to the north (Map 5). Although these areas to the north are miles from Birch and Big Bear Springs, they are the most likely sources for recharge. These areas are topographically higher and receive the greatest amount of precipitation. There are perennial streams in these higher areas. The Star Point Mine determined that the stream in Nuck Woodward Canyon has losing reaches that recharge the ground-water system through the Trail Canyon Fault. Losing reaches have not been confirmed in streams directly upgradient of Birch and Big Bear Springs, but Wild Cattle, Gentry, and McCadden Hollows align with large faults, where fractures and brecciated zones that would accommodate recharge are undoubtedly present. Strata dip generally southward from the structural high near the middle of Nuck Woodward Canyon. Information from boreholes, mines, and the Tie Fork Springs confirm that the potentiometric gradient is from north to south, with an eastward component, and the potentiometric surface is higher in the Bear Canyon Graben than to the east or west. The north - south orientation of the faults and fractures limits east-west ground-water flow and favors flow towards Tie Fork, Birch, and Big Bear Springs from these northern areas.

### **Tie Fork Springs**

#### *Development History and Hydrogeology*

In 1981 and 1982, CVSSD built a new water line to Tie Fork Canyon and developed Upper Tie Fork Spring (Map 6). Ground-water flow at Upper Tie Fork was originally from two seismic-exploration shot holes, of unknown age, located where the Trail Canyon Fault (East Fault of the Pleasant Valley Graben) crosses Tie Fork Canyon. The depths to which these two wells were drilled are unknown. They were drilled into a breccia zone of the Trail Canyon Fault, or into an open sandstone fracture zone. Either they were never sealed or the seals failed, and water flowed to the surface from both holes. CVSSD developed these water sources by inserting pipe as far as it would go, and combined the flows into one line. In December 1982, Upper Tie Fork Spring was placed on the CVSSD system. Average flow was 85 gpm through 1987.

Artesian conditions were encountered in exploratory drill hole 85-35-1, drilled near the junction of Wild Cattle Hollow and Gentry Hollow in Tie Fork Canyon. This hole is located upstream of the Upper Tie Fork Spring and Trail Canyon Fault. The driller noted that fractures were intercepted at a depth of 357 feet. Information available indicates that these fractures are located within the Spring Canyon Member of the Star Point Sandstone (Star Point Mine Plan). Drill Hole 85-35-1 was deeded to Huntington City in 1988. CVSSD tried to develop this borehole as a water well. Pipe was installed, perforated, and hooked into the Upper Tie Fork system. However, the well ceased to flow and was removed from the CVSSD system. The cause of the failure is not known; Darrel Leamaster of CVSSD suspects a seal inside the well failed (personal communication, February 13, 2007).

In October 1993, Upper Tie Fork Spring was removed from the town drinking water system under an agreement with PMC, because a potential for mining impacts was identified at the Star Point Mine. Lower Tie Fork Spring was developed and put into the CVSSD system as water replacement. Lower Tie Fork Spring is west of the Trail Canyon Fault, approximately one-half mile downstream from Upper Tie Fork. After mining and pumping in the Gentry Ridge Horst ended, the flow from Upper Tie Fork was returned to the CVSSD system.

#### *Water Quantity*

The absence of marked seasonal variation in flow volume at Upper Tie Fork Spring indicates a large recharge area, storage capacity, and minimal direct influence from seasonal precipitation and snowmelt. A flow increase was recorded at Upper Tie Fork Spring in August 1988. This increase correlates with a 5.3 magnitude earthquake on August 14, 1988. After the earthquake, Upper Tie Fork Spring flow reached 133 gpm, then slowly dropped to 86 gpm in August and September 1991 (Figures 1, 5, and 8). Flows observed prior to the earthquake averaged 84 gpm.

Mining beneath Gentry Ridge appears to have caused a direct and rapid decrease in flow to Upper Tie Fork Spring. This is related to the pumping of water across the Bear Canyon Fault from June 1992 through December 1997. However, some of the decrease can be attributed to the 1987 - 1993 drought (Figure 14a). A surge in flow related to an August 1998 earthquake counteracted and somewhat masked this decline (Figure 8). Flow declined to a minimum of 33 gpm in 1995, but recovered as pumping rates dropped and returned to pre-pumping levels by mid-1996, at which time there was still a small volume of water being pumped from Gentry Ridge (Figure 1).

Mining activities and the 1988 earthquake affected the flow rate at Upper Tie Fork Spring (Figure 5). The quick response time at the Upper Tie Fork Spring to the Gentry Ridge pumping indicates a fault - fracture type flow system is present. Discharge dropped from a pre-pumping average of over 80 gpm to 39 gpm in May and June 1995. Flow rebounded, and by the time the Gentry Ridge Horst pumping ceased, discharge was above pre-pumping levels, reaching 165 gpm in August 2002 (Figure 8). Monthly flow reached a maximum of 142 gpm in October 1998 and hovered at around 125 gpm until 2002 (Figure 14a). In 2002, flow at Upper Tie Fork Spring again surged from May to August before it dropped precipitously and settled at approximately 75

gpm: since 2002, flow at Big Bear Spring has declined while flow at Lower Tie Fork Spring has increased. The reason for these sudden changes at Lower Tie Fork Spring is unknown (Personal communication, Darrel Leamaster, February 13, 2007). They do not appear to be related to any coal mining activities.

Additional discussion related to water quantity at Upper Tie Fork Spring is found in the section on INTERCEPTION AND WELL INFORMATION for the Star Point Mine.

Flow at Lower Tie Fork Spring, developed in December 1993, has marked seasonal variation (Figure 8). Because it was developed while the Star Point Mine was pumping from the Gentry Ridge Horst, pre-pumping data are lacking. High flow has typically been in April or May and the low around September. High-flow rate is typically two to three times that of low-flow. Low flow at Lower Tie Fork Spring declined from 62 gpm in 1994 to 41 gpm in 1995, recovered a little during the remainder of the pumping period, and reached 52 gpm in 1999, but flow did not rebound to the degree that it did at Upper Tie Fork Spring. Since 1999, the low-flow rate has fluctuated but has never been higher than 47 gpm (2003), but 1999 to 2004 was a period of drought. Low flow at Lower Tie Fork in October 1995 (41 gpm) lagged four months behind the lowest flow recorded at Upper Tie Fork Spring, 39 gpm in May and June 1995, but data from Upper Tie Fork do not show seasonal recession and it is not possible to compare the cyclicity of the two springs.

### *Water Quality*

Water quality at the Upper Tie Fork Spring was affected by pumping at the Bear Canyon graben. The pH dropped as pumping started, reaching lows of 6 in January and June 1993. As pumping increased through 1994, pH values returned to pre-pumping values, although some elevated values were recorded. When pumping decreased in 1997, pH levels rose to over 8. After pumping stopped, the pH returned to pre-pumping values (Figure 9a).

When pumping started and as pH levels dropped, sulfate concentrations jumped, reaching a high of 66 mg/L in September 1992, but soon dropped back to pre-pumping levels. By January 1996, when pumping rates had dropped and pH values had risen, sulfate concentrations were near the pre-mining levels. After pumping stopped, the sulfate concentrations appeared to be in an upward trend, but there has been no water quality analysis since 2001 (Figure 9a).

Bicarbonate<sup>2</sup> generally remained in the range of pre-pumping values during pumping, even though higher than usual concentrations were measured in late 1993. After pumping stopped, bicarbonate concentrations were consistently high (Figure 9b). TDS fell during the pumping period, but recovered when pumping ceased, and several high values were reported during the post-pumping period (Figure 9b). The ratio of bicarbonate and sulfate to TDS increased over the sampling period, but at the time the Star Point Mine stopped doing water-quality analysis in 2001, the ratios appear to have been dropping back towards pre-mining levels.(Figure 10).

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2 Bicarbonate values in Figures 9b and 10 have been adjusted by a factor of 0.4917 to account for volatilization of H<sub>2</sub>O and CO<sub>2</sub> during determination of TDS from dry residue (see Hem, 1992).

Increases in sulfate, and possibly other chemical constituents, to concentrations similar to the Blackhawk Formation (Figure 9a and 9b) may result from mining. These chemical changes may be the result from the mixing of Blackhawk Formation ground water with North Horn ground water.

Changes between dry and wet climatic cycles may effect oxidation and reduction within the hydrologic systems and create water chemistry changes similar to those observed. Variations in TDS, sulfate, bicarbonate, and pH may occur during future climatic cycles, independent of any mining activity.

### **Birch Spring**

#### *Development History*

Birch Spring was originally developed in the 1970's by the NEWUA (now NEWUSSD). The spring boxes were updated in 1977, and the lines to the spring boxes were re-developed in 1980 (Informal Conferences - permit renewal, cause No. C/015/025). Additional redevelopment work was done in the fall of 1984 because flow rates from the collection system were not as large as expected. Redevelopment in 1984 included some blasting and backhoe work conducted to increase flow rates, followed by collection system burial under impervious material. The water was re-connected for use after the 1984 development work. The collection system was developed again in 1986 (Figures 11a and 11b). In a letter dated April 13, 1998, Co-Op Mining Company posited that explosives used to redevelop Birch Spring in 1984 and 1986 may have opened fracture flow paths for water to by-pass the spring collection system.

The area over the spring collection system is well vegetated, which can reduce spring discharge through plant uptake and water transpiration. In 1998 the overflow pipe at the collection box was cleared of roots that were blocking flow. Roots may also have been clogging the collection lines, and silt may have accumulated in the lines as well.

In September 1998, NEWUA opened spring boxes #1 and #2. Pete Hess from UDOGM accompanied Jack Stoyhoff from NEWUA. Mr. Hess noted that water was running over the top of collection box #1 when it was uncovered and that when opened, it was full of gravel and sediment. It was estimated that approximately 15 gpm flowed from source #1 after cleaning the box. Box #2 was also opened and cleaned, and several of the pipes in the collection system were cleaned or replaced. After this work in 1998, flow at Birch Spring remained at approximately 15 gpm until 2000, when it increased to 25 gpm. It currently flows approximately 20 gpm (Figure 11). This matches the flow reported by Danielson in 1978-1979 but is still well below the highs recorded in 1986 through 1990.

#### *Hydrogeology*

Birch Spring issues from a fault and fractures in the Panther Tongue of the Star Point Sandstone, west of the Bear Canyon Mine. It has been hypothesized that this fault is a splay from the Blind Canyon or Dry Canyon Fault (Map 4); however, field investigations have not

identified a connection to any major fault. Fractures in the Birch Spring area are parallel, with consistent vertical and north-south orientation, not towards the mine. Transverse, interconnecting fractures have not been observed near Trail and Bear Canyon Mines, indicating that lateral hydraulic interconnectivity between faults and fractures is poor or nonexistent. Water movement across major faults, such as the Dry Canyon Fault that separates the mine from Birch Spring, does not seem likely based on general experience and information presented to date.

The Trail Canyon Mine lies directly in line with the northward projection of the Birch Spring fault. The Trail Canyon mine-workings map makes no note of this fault, but the text of the Trail Canyon Mine plan mentions several minor faults encountered within the mine. There is no mention in the Trail Canyon Mine Plan of significant or continuous flows into the mine workings from any source.

Secondary faults and fractures, oblique to the main north-south structural fabric and able to transport water from the saturated sand channel exposed in the Bear Canyon Mine across the Blind Canyon fault to Birch Spring, have been inferred (Map 4). In the southern region of the Bear Canyon Mine, joint and fracture sets oriented N 15° E to N 17° E and a second set of minor joints oriented N 60° E have been described (informal conferences - Chris Hansen, Earth Fax Engineering). Mining in the Tank Seam has exposed a fault near the Blind Canyon Fault, north of the Blind Canyon Fan Portal, that strikes N 17° E, is offset 1.5 feet, and is down-dropped to the west; it was also observed in the Blind Canyon Seam (letter from the Co-Op Mining Company, April 13, 1998). According to Co-Op, the fault appears to terminate near the southern end of the Third West Bleeders, it did not intersect the Blind Canyon channel sandstone, and it appeared closed. An inferred fault has been projected northwest of the Blind Canyon channel sandstone (Map 4).

Farther north, in the Star Point Mine permit area, faults and joint sets that formed perpendicular to regional extensional stresses are oriented N 5° W, N 6° E, and N 14° E. These joint sets are open. Ground and surface-water migration is common along these fracture systems (Star Point Mine Plan). The Dry Canyon Fault could provide a flow path from the Shattered Zone, adjacent to Tie Fork Canyon, to Birch Spring (Maps 4 and 5); however, there are no data substantiating that the water flowing from Birch Spring originates here.

Information was collected during a field visit by Charles Reynolds, Environmental Engineer for Co-Op, and Jim Smith, UDOGM geologist, on October 15, 1998. The field-visit form and summary memo from Co-Op dated December 22, 1998 are presented in Appendix C. In summary, the documents state the following:

- The fractures do not completely converge, and they parallel the Blind Canyon Fault within the mapped area.
- Most of the area is jointed. Joints appear to be gradually converging up slope and may converge northward, upward, or both.

If the fracture zones or joint sets are open as a result of extensional stress, they may be more likely to carry flow. Detailed mapping of faults and joints would be needed to fully

understand the relationship, if any, of these fractures to the hydrogeology of Birch Spring. However, Birch Spring flows at a relatively steady rate, showing little or no seasonal variation. Isotopic data also indicate there is no component of modern water in the Birch Spring discharge. These indicate that, even though numerous joints and fractures are found in the outcrops surrounding the spring, the system is not recharged locally through these fractures.

The most likely recharge area is farther north. Faults that extend north to the west side of the Shattered Zone align with Birch Spring. Other faults that flank Birch Spring extend to the Gentry Ridge Horst and Bear Canyon Graben and farther north (Map 5). Although they are several miles from Birch Spring, these are the most likely sources for recharge to this spring. These areas to the north are topographically higher and receive greater amounts of precipitation. There are perennial streams in these higher areas. The Star Point Mine determined that the stream in Nuck Woodward Canyon has losing reaches that recharge the ground-water system through the Trail Canyon Fault. Losing reaches have not been confirmed in streams directly upgradient of Birch Spring, but Wild Cattle and Gentry Hollows align with mappable faults, and fractures and brecciated zones that would accommodate recharge are undoubtedly present. Strata dip generally southward from the structural high near the middle of Nuck Woodward Canyon, and information from boreholes, mines, and the Tie Fork Springs confirm that the potentiometric gradient is from north to south, with an eastward component in the Storrs and Panther Members. The potentiometric surface is higher in the Bear Canyon Graben than to the east or west. The north - south orientation of the faults and fractures limits east to west ground-water flow and favors flow towards Birch Spring from these northern areas.

Except for the large channel-sandstone intercepted in the Blind Canyon Seam in the #1 Mine, there were not significant inflows to the Bear Canyon Mine. Individual ground-water inflows were on the order of 5 gpm, and they did not persist. Mining did not intercept the Spring Canyon Member potentiometric surface (Bear Canyon Mine Plan, Plate 7J-1).

An issue presented by NEWUA was whether water intercepted in the Bear Canyon Mine at the channel sandstone, monitored at sites SBC-9 and SBC-10, decreased recharge to Birch Spring. Not only is there no evident hydrologic connection between Birch Spring, the mine, and the channel sandstone, but also the isotopic characteristics of water from between the Dry Canyon and Blind Canyon Faults are incompatible with flow from the mine to Birch Spring (Bear Canyon Mine Plan, Appendix 7-J).

Mining in the McCadden Hollow block is not likely to interfere with the Panther Member hydrologic system and flow to Birch Spring and Big Bear Spring. To access the Blind Canyon Seam in McCadden Hollow, entries will need to cross the Bear Canyon Fault. Fractures and brecciated zones adjacent to the fault may yield some water, but the fault crossing will be above the potentiometric surface, on both sides of the fault (Bear Canyon Mine Plan, Plate 7J-2). Tunnels are to be built down to the Blind Canyon Seam on the McCadden Hollow side of the fault. Projected mining in the McCadden Hollow block is to be done below the Spring Canyon potentiometric surface. Lower Blackhawk strata that lie between the Blind Canyon Seam and the Spring Canyon Sandstone will greatly reduce the possibility of groundwater upwelling through the mine floor. In the McCadden Hollow area, the Star Point Sandstone very likely consists of three distinct sandstone members, with separate hydrologic systems and potentiometric surfaces.

This will isolate the hydrologic system in the Panther Member, which supplies Birch and Big Bear Springs, from possible impacts to the shallower members: reducing the head in the Spring Canyon Member would not be expected to affect flow at Birch and Big Bear Springs. Furthermore, the Dry Canyon Fault will act to laterally isolate Birch Spring from effects of mining in the McCadden block. Finally, encountering a large volume of water in the McCadden block would probably stop mining in this block because of poor economic return.

### *Water Quantity*

Birch Spring is located in Huntington Canyon, about one mile south of the Trail Canyon Mine. Flow measurements done prior to installation of a flow meter in January 1992 are very sporadic and many are of questionable reliability. The more reliable flow measurements during this period ranged from 9 to 100 gpm (Figures 11). From 1992 through 2000, flows averaged 22 gpm; however, there was a slight downward trend over this period. Because mining activities ceased at Trail Canyon Mine in 1982, there is little probability this downward trend is related to activities at Trail Canyon Mine.

Flow data indicate two significant concerns: 1) decreased flow was observed from 1991 to 1998, and 2) peak flows such as those recorded in December 1988, June 1989, October 1989 through January 1990, and June 1990, have not been seen since. These peaks occurred in the middle of the 1987 – 1993 drought, so they were not caused by increased precipitation. The 1988 peak is very likely a result of the 1988 earthquake, which produced a jump in the flow at nearby Upper Tie Fork Spring. The remaining peaks may or may not be related to the earthquake.

The pre-1996 Star Point Mine Plan provided information on flow at Birch Spring from January 1985 through December 1990. It is not available from other sources. The spring flow information was obtained by Ben Grimes, who was employed by Star Point Mine but at the same time was also President of NEWUA. Although these flow data have been used in the past in matters relating to Birch Spring, UDOGM no longer considers the data from January 1985 to November 1988 to be valid. The data were collected by Jimmy Staker, an employee of NEWUA, who kept the records of his flow measurements at his home. Mr. Staker died several years ago and his original records cannot be found. Comparing the Birch Spring data between January 1985 and November 1988 with the data from Upper Tie Fork Spring for the same period, it is evident that it is the same data set. CVSSD's Upper Tie Fork records are continuous and can be confirmed back to December 1982, and the reported flows are more consistent with historic flows at Upper Tie Fork and less consistent with Birch Spring flow data. The data from December 1988 to December 1990 are also open to question because there is no way to confirm them.

NEWUA began measuring Birch Spring flows monthly between January and December 1991, using a bucket and stopwatch. After January 1992, an in-line flow meter was used and checked monthly with a bucket and stopwatch. Prior to 1991, Co-Op measured only the overflow of the collection system, so Co-Op's early measurements do not include the flow within the collection system. Since 1991, Co-Op has at times reported NEWUA's measurements and at other times has made independent measurements. Star Point began independent quarterly

monitoring in October 1992. Since 1991, the independent measurements of Star Point and Co-Op closely match NEWUA's data.

Peak flow discharges, attributed to Staker's measurements, reached 117 gpm during December 1988, 100 gpm in June 1989, 230 gpm in October 1989 through January 1990 and 85 gpm in June 1990. Based on Staker's data, each of these four peak flows at Birch Spring was followed by what appear to be periods of baseflow recession (Figure 11a). Both Co-Op and NEWUA data confirm high flow during the October 1989 through January 1990 period; 129 gpm (of overflow) in October 1989 from Co-Op, and 100 gpm in January 1990 from NEWUA. Bill Malencik of UDOGM (memo dated November 1, 1989) measured 150 gpm on October 25, 1989, which did not include the flow in the adjacent ditch that was reported to flow 80 gpm on November 3, 1989.

Following this series of peak events, flows declined rapidly. Flow was 40 gpm in September 1990. Flows held fairly steady at around 33 gpm through 1991, but then began decreasing slowly in January 1992, reaching a low of 14.5 gpm in May 1997. From May 1997 until the spring was redeveloped by NEWUA in September and October 1998, flow increased slowly, reaching a maximum of 21 gpm in October 1997. Since the 1998 redevelopment, flow has been as high as 27 gpm (Star point data, March 2000), but flows as low as 15 gpm (Star Point and Bear Canyon data, May and June 1999) have been recorded during the same period. Data since March 2000 indicate flow is consistently above 25 gpm.

### *Peak Flow Events*

Isotopic data and the lack of seasonal variation indicate Birch Spring baseflow comes from a large system that is buffered from seasonal fluctuations. The water source for the 1988 to 1990 peak flows was probably from a separate, perhaps local source. Three hypotheses explaining these peak flows have been considered: 1) water may have been released from the bulkheads at Trail Canyon, 2) water intercepted within the Bear Canyon Mine was pumped from the Blind Canyon Fan Portal into Dry Canyon and reached Birch Spring through subsidence above the Trail Canyon Mine workings (Map 4), and 3) the water originated from the sump in the south workings at the Bear Canyon Mine.

### *First Hypothesis*

The first hypothesis is that the 1988 to 1990 peak flows at Birch Spring originated from water stored behind bulkheads in the Trail Canyon Mine. Flow data for Birch Spring that are presented by PMC for August, September, October, and November 1988 are considered invalid - as discussed above - but the high flow rates measured in December 1988 and later appear to be followed by periods of recession (Figure 11). These data also indicate a possible correlation with the August 14, 1988 earthquake. Hypothetically, water behind bulkheads in the Trail Canyon Mine was released during the earthquake and traveled along fault and joint systems to Birch Spring. However, it seems unlikely the three subsequent peak flows, which occurred sometime after the earthquake, would be related to the earthquake.

A large sediment load was observed in Birch Spring collection system during the peak flows. A possible source of sediment in water originating at the Trail Canyon Mine would be a connection between the ground water and the surface. The only documented connection is a subsidence area observed on October 28, 1996 (Map 4). The surface subsidence effects in this area were on both sides of Dry Canyon and over a 100-foot-long section that dropped 6 to 8 feet along the ephemeral channel. This subsided area occurs over a mapped fault, the Dry Canyon Fault (west of the Blind Canyon Fault), that passes near Birch Spring. The subsidence was first identified on a map presented by Co-Op for the Trail Canyon Mine and dated March 22, 1983.

### Second Hypothesis

The second hypothesis, presented by Mr. Galen Atwood for NEWUA during the 1996 Bear Canyon Mine informal conferences, contended that water intercepted in the Bear Canyon Mine was pumped from the mine through the Blind Canyon Fan Portal into Dry Canyon. This would have been in the late summer of 1989, when the 230 gpm flows were measured at Birch Spring. No factual evidence was presented for this hypotheses, although oil-and-grease, sediment, and dissolved solids levels and fecal coliform bacteria counts increased in the Birch Spring water during these high flows of late 1989 to early 1990. Isotopic data and the lack of seasonal variation since 1988 - 1990 indicate local recharge around Birch Spring does not normally occur. This may be due to low availability of water under normal conditions rather than hydraulic isolation from the surface, and a large flush of water into local drainages might have reached the Panther system and emerged at Birch Spring. Again, the Trail Canyon Mine subsidence might have allowed connection along the Dry Canyon Fault to Birch Spring. This hypothesis does not adequately explain how peaks occurred at Birch Spring several years in a row without being detected at the surface, but could perhaps explain the extreme flows in late summer of 1989.

### Third Hypothesis

The third hypothesis suggests water sumped into the old workings at the Bear Canyon Mine resulted in the peak flows at Birch Spring. Pumping of water into the old south workings apparently began sometime after mid-1989 when water from the Blind Canyon channel sandstone began flowing into the North Mains (Figure 6), and ended in April 1991 when discharge to Bear Creek began under a UPDES permit. The water users have stated that water was flowing over the road below Birch Spring during this period.

Potential flow paths from this sump to Birch Spring could have resulted from subsidence features occurring adjacent to the mine sump area, at the southern end of the permit area (Map 4). This subsidence feature is located in the small drainage tributary to the alcove where Birch Spring is located. Co-Op mined beyond the permit area boundary in an area beneath the drainage in 1985. During mining a subsidence hole, with an average six-foot depth, developed in the drainage channel and a large fracture formed approximately 100 feet west of the subsidence hole. Ventilation stoppings and a barricade were installed in the mine, but no seal was installed (memo to file from Peter Hess, March 27, 1995). Approximately 150 feet southeast and up-slope from the larger hole, a smaller diameter hole, approximately 30 feet deep, subsided. It is unknown when this subsidence hole formed. The holes and fractures were observed during a

UDOGM inspection in the fall of 1994 and are described in Appendix 3-N of the Bear Canyon Mine Plan. (NOV N94-46-4-1B was issued December 12, 1994, the subsidence damage in the drainage was mitigated, and the NOV was terminated in 1997.)

The subsidence holes and fractures might have facilitated a flow path between the sump and Birch Spring that would not require any substantial head increase in the old-workings sump. Water was not suspected to have exited from the subsidence features at the ground elevation, because the old workings are separated from the active mine by bulkheads. These bulkheads are unable to contain pressures from a water reservoir with a large hydraulic head. Water would have seeped from behind the bulkheads if approximately a 20 ft head required for discharge at the surface developed. According to Co-Op there was no seepage from the bulkheads. However, the subsidence features might have provided a subsurface path for water and a source for sediment from the old workings to Birch Spring.

The adjacent Big Bear Spring also exhibited excess water during the Birch Spring peak flows. In October 1990 water was observed exiting the cliff face south of the Bear Canyon Mine. In December 1990 through January 1991, icicles were noticed on the cliffs above Big Bear Springs by UDOGM personnel and by Mr. Bryce Montgomery, hydrogeologist for CVSSD. It is believed that this discharge resulted from the water pumped into the abandoned workings at the south end of the Bear Canyon Mine. Sulfate, TDS, and oil and grease also increased in the Big Bear Spring water during this period.

According to the Informal Hearing, Cause No. C/015/025, UDOGM, under Findings of Fact: Relative Findings:

#6 "There is evidence that pumping [in the Bear Canyon Mine] may have influenced quantity of flow from outcroppings at or near Big Bear or Birch Spring in the recent past."

#7: "Pumping into the abandoned workings at the south end of the mine, directly north of the existing Bear Canyon Mine may have influenced the quantity of water seeping from outcrops above Big Bear and Birch Spring."

Water flowed from the cliffs at approximately the same elevation and the same stratigraphic section as the coal seam and the coal mine. Horizontal flow through the Blackhawk Formation is somewhat easier than vertical flow because of multiple layers of low-permeability clay, siltstone, and sandstone. As in other scenarios, it is most likely that faults or fractures provide a path from the mine workings to Birch Spring, which flows from a stratigraphic unit below the mine sump.

#### *Long-term Declines in Flow*

Flow rates from 9.3 gpm to 23 gpm were recorded at Birch Spring by the USGS (Danielson and others, 1981) during a drought period in 1978 and 1979 (Figure 11).

It is unclear whether the peak flows in 1988 to 1990 influenced long-term discharge from the spring. The lack of congruity and consistency in flow data makes such a determination difficult.

Based on NEWUA records, flow at Birch Spring declined from 33 gpm in February 1990 to about 19 gpm in 1997, with a 16 gpm low flow recorded May 1999. This decline in flow could have resulted from the drought that began in 1987 and continued through early 1993. Flows continued to decline to a low of 14 gpm recorded on June 1, 1999. Flows recovered from this low. NEWUSSD reported the spring was flowing 22.5 gpm in January 2007, and data since March 2000 indicate flow averages over 20 gpm.

Birch Spring was originally developed in the 1970's. The spring boxes were updated in 1977, and the lines to the spring boxes were re-developed in 1980. Because flow rates from the collection system were not as large as expected, additional redevelopment work was done in the fall of 1984 and again in 1986. Co-Op has suggested that the explosives used to redevelop Birch Spring in 1984 and 1986 may have opened fracture flow paths for water to by-pass the spring collection system (Co-Op letter, April 13, 1998).

Charles Reynolds noted in 1997 that water was issuing from the area between Huntington Creek and Birch Spring in a seep area that may have existed for two or three years, estimating from the vegetative growth in the area surrounding the seep. Co-Op felt this seep was the result of the collection system's reduced capacity and reduced ability to carry the available water.

The area over the spring collection system is well vegetated, which can reduce spring discharge through plant uptake and water transpiration. In 1998, the overflow pipe at the collection box was cleared of roots that were blocking flow. Silt may have accumulated in the lines as well.

In September 1998, NEWUA opened spring boxes #1 and #2. Pete Hess from UDOGM accompanied Jack Stoyhoff from NEWUA. Mr. Hess noted that water was running over the top of collection box #1 when it was uncovered, and that when opened it was full of gravel and sediment. It was estimated that approximately 15 gpm flowed from source #1 after cleaning the box.

Information presented to date is not adequate to identify the cause of the decline in flow at Birch Spring from 1990 to 1999, but it does not support the assertion that the decrease in flow was the result of mining operations. There are spring development and maintenance history aspects that affect water quantity, but these are not all clearly documented or understood. Many unanswered questions about the resource at Birch Spring remain. With time, additional data and analyses from the mine operators and the water users may provide clarification.

#### *Water Quality*

Baseline water quality samples were collected at Birch Spring by Trail Canyon Mine from 1991 to 1993. Bear Canyon Mine collected baseline data in 1986, and has continued to monitor Birch Spring under the Bear Canyon Mine plan. Specific conductance and TDS both show large differences between minimum and maximum values. However, such anomalies may

be characteristic of high and low flows associated with natural climatic and erosional processes, especially if the spring is influenced by surface hydrologic events. The main water quality issues at Birch Spring have been the temporary increases in coliform bacteria, dissolved solids, oil-and-grease, and sediment during the 1989 - 1990 high flow periods. There have been no significant overall changes in water chemistry at this spring during this monitoring period; therefore, it does not appear there have been any permanent or long-term adverse effects from mining. Monitoring of this spring will continue in conjunction with the Bear Canyon Mine permit (C/015/025).

Data in the UDOGM database, summarized in Table IV-3, show SBC-9 and SBC-10 have lower sulfate, bicarbonate, and chloride mean concentrations than Birch Spring, although high and low values sometimes do not show as clear a distinction. Mean solute concentrations tabulated in Table 3 of Appendix 7-J of the, Bear Canyon Mine Plan are basically in agreement with Table IV-3.

**TABLE IV-3: SBC-9, SBC-10 and Birch Spring**

Station	Bicarbonate (mg/L)			Chloride (mg/L)			Sulfate (mg/L)		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Birch Spring	373	439	281	8	25	3	111	298	38
SBC-9 – SBC-9A	355	440	270	6.0	27	0.5	62	347	20
SBC-10	321	412	152	8.4	20	1.0	52	100	5.0

Data from Bear Canyon Mine

Stiff diagrams are shown on Figure 15 of Appendix 7-J. Stiff diagrams for SBC-9, SBC-10, Birch and Big Bear Springs, and springs in Trail Canyon are similar in appearance.

Water quality varied some over time at SBC-10 and SBC-9/9A, most notably the jumps in chloride concentrations in 1992 and 1998 (Figures 12 and 13a). TDS and sulfate also had some variation in concentration. Values for sulfate in late 1990 and early 1991 at SBC-9 were greater than two standard deviations above average. The variability of these data may indicate intrinsic variability in the sand channel water or extrinsic influences from other water sources or mining. Water sampled at SBC-9/9A has been taken from a sump that was relocated at least once during mining, and some samples may have been taken directly from the channel sandstone. Samples from SBC-13, which are believed to be flowing through gob from the SBC-10 area, show water quality improving over time (Figure 13b), perhaps indicating that soluble minerals are being flushed from the gob.

#### *Water Dating*

Results are summarized in Table IV-4. Sample locations are on Map 4. Samples obtained on May 15, 1996 were collected during a joint sampling effort between the water users, represented by Peter Nielsen of SECOR, and Co-Op. Data from Mayo and Associates are in Table 4 of the Bear Canyon Mine PHC (Bear Canyon Mine Plan, Appendix 7-J). Analysis results for one sample from Birch Spring were obtained from the Star Point Mine Plan. The date

was not provided, but the sample was collected prior to 1991, because the analytical results were first presented in 1991.

Table IV-4: Water Age Dating						
Source		Date	Sample Source	Parameter		
				TU	Years Mean Residence Time * (Carbon 14 age)	δ34S
Birch Spring	SBC-5	5/15/96	Co-Op	0.35		+3.8
		Not known	Star Point Mine	0.98		
	SBC-5 Source #1 Source #2 Overflow	4/27/92	Earth Fax (Bear Canyon Mine Plan Appendix 7-J Table 4 4/30/93)	1.12		
		5/26/98	Mayo and Associates - Co-Op	0.49	1,700*	+3.0
		10/29/98		0.33	3,600*	+5.1
				0.37	2,500*	+5.0
				0.47	1,100*	-7.8
SBC-9	11/13/96	Mayo and Associates - Co-Op	0.50	1,400*		
	1/6/99	Co-Op	3.62	2,200*	+3.5	
DH-2 (Spring Canyon)		Mayo and Associates - Co-Op	-0.3	900*		
	5/15/96	SECOR	0.40		+11.4	
3rd West Bleeder	11/13/96	Mayo and Associates - Co-Op		500*		
	5/15/96	SECOR	2.22		+10.8	
3rd West South	11/13/96	Mayo and Associates - Co-Op		5,400*		
	5/15/96	SECOR	0.0		-0.6	
Big Bear Spring	5/15/96	Co-Op	14.2		5.4	
	pre-1991	Star Point Mine	17.7			
	11/13/96	Mayo and Associates - Co-Op	15.8			
	5/26/98		14	Mixed	+6.0	
	10/29/98		17	Mixed	+5.1	
Hiawatha - Mohrland Portal	6/10/98 and 10/12/98	Mayo and Associates - Co-Op	5.52 5.41	Mixed/9,000* Mixed/9,000*	22	
Star Point Mine 3 <sup>rd</sup> West roof				2,500* (8,670)		

• - Mayo and Associates has revised <sup>14</sup>C ages shown on the lab reports to account for *dead carbon*  
 3<sup>rd</sup> West roof 2,500\* (8,670)

Except for one slightly elevated value of 3.62 TU from June 1, 1999 for SBC-9, there is no indication that modern water is present in Birch Spring, or in the sand channel at SBC-9. Water from the Spring Canyon Member in DH-2 is younger (900 years) than the Blind Canyon channel sandstone (1,400-2,200). Computed mean residence times were determined for the data presented by Mayo and Associates using the Pearson, Mooks, and Fontes models. The ages from

oldest to youngest are; 3rd West South, Birch Spring, SBC-9, and 3rd West Bleeder (Map 4).

Although Big Bear Spring has chemical characteristics similar to Birch Spring, dating indicates *mixed* waters with high TU identifying a modern or *young* component in the water recharging Big Bear Spring (Table IV-4). Chemical characteristics of the Trail Canyon springs are similar to Birch and Big Bear Springs; however, sampling to determine the mean residence time was not conducted on any Trail Canyon springs.

Conclusions made from the water dating analyses are:

1. 1) the age of the water at SBC-9 (1,400 to 2,200 years mean residence time) and Birch Spring (1,100 to 3,600 years mean residence time) are similar, but all data considered together might favor Birch Spring as being slightly older,
2. no modern water was found at Birch Spring or SBC-9 water source, and
3. water from the 3rd West Bleeders is younger in age (500 years mean residence time) than Birch Spring.

Water flowing from Mohrland Portal is the oldest encountered in the Mayo and Associates samples, but TU values indicate a mixture with modern waters.

$\delta^{34}\text{S}$  represents the isotopic sulfur ratio and is used to identify sulfate sources in ground water. The Third West Bleeders and SBC- 9 have similar  $\delta^{34}\text{S}$  levels, while the third-west south and Birch Spring are lower. These  $\delta^{34}\text{S}$  levels become important if geochemical modeling is conducted.

## **Big Bear Spring**

### *Development History*

The Big Bear Spring was developed as a water source by Huntington City around 1920. At that time, a four-inch transmission line was used to convey the water, but the line capacity was not large enough to transport all water available during peak flows. In 1977 Huntington City upgraded the spring boxes and collection systems and installed a meter. This meter was used to collect spring flow data and was operating when Terry Danielson (Danielson and others, 1981) collected samples for the USGS in April through December 1978.

In 1981 the CVSSD replaced the four-inch line with a six-inch line and a new meter, which is adequate to transport all the spring flow. Following the new meter installation, flows are measured on the 15th and last day of each month by the CVSSD. The collection system was again modified in early 2001 to capture additional flow, but the results have not yet been determined. The telemetric system, connected to the spring collection system in 1995, currently records hourly flow rates. The spring was redeveloped in 2000 in an attempt to capture flow that was bypassing the collection system.

### *Hydrogeology*

Big Bear Spring issues from fractures in the Panther Tongue of the Star Point Sandstone. The fractures and faults that extend north, to and beyond the Shattered Zone and the Bear Canyon Graben, align with Big Bear Spring (Map 5). Although these areas to the north are several miles from Big Bear Spring, they are the most likely sources for recharge to these springs. These areas are topographically higher and receive the greatest amount of precipitation. There are perennial streams in these higher areas to the north. The Star Point Mine determined that the stream in Nuck Woodward Canyon has losing reaches that recharge the ground-water system through the Trail Canyon Fault. Losing reaches have not been confirmed in streams directly upgradient of Big Bear Spring, but Wild Cattle, Gentry, and McCadden Hollows align with large faults, and fractures and brecciated zones that would accommodate recharge are undoubtedly present. Strata dip generally southward from the structural high near the middle of Nuck Woodward Canyon. Information from boreholes, mines, and the Tie Fork Springs confirm that the potentiometric gradient is to the south, with an eastward component in the Storrs and Panther Members, and the potentiometric surface is higher in the Bear Canyon Graben than to the east or west. The faults and fractures limit east-west ground-water flow and favor flow towards Big Bear Spring from these northern areas.

It has also been suggested that recharge came from Bear Creek and local faults and fractures. Although recharge to the spring from the creek is not confirmed, baseflow to Bear Creek comes from the Bear Canyon Fault.

Except for the large channel-sandstone intercepted in the Blind Canyon Seam in the #1 Mine, there were not significant inflows to the Bear Canyon Mine, even in the Hiawatha Seam workings directly above the Star Point Sandstone. Ground-water inflows were on the order of 5 gpm, and individual sources did not persist. In-mine well DH-1 A was completed in the Spring Canyon Sandstone, directly under the Hiawatha Seam. Water in DH-1A was approximately 5 feet below the coal seam.

Mining in the McCadden Hollow block is not likely to interfere with the Panther Member hydrologic system and flow to Birch Spring and Big Bear Spring. To access the Blind Canyon Seam in McCadden Hollow, entries will need to cross the Bear Canyon Fault. Fractures and brecciated zones adjacent to the fault may yield some water, but the fault crossing will be above the potentiometric surface, on both sides of the fault (Bear Canyon Mine Plan, Plate 7J-2). Tunnels will need to be built down to the Blind Canyon Seam on the McCadden Hollow side of the fault. Projected mining in the McCadden Hollow block is to be done below the Spring Canyon potentiometric surface. Lower Blackhawk strata that lie between the Blind Canyon Seam and the Spring Canyon Sandstone will greatly reduce the possibility of groundwater upwelling through the mine floor. In the McCadden Hollow area, the Star Point Sandstone very likely consists of three distinct sandstone members, with separate hydrologic systems. This will isolate the Panther Member hydrologic system that supplies Birch and Big Bear Springs from impacts in shallower members. Finally, if a large volume of water were to be encountered in the McCadden block, the cost of moving the water could stop further mining.

### *Water Quantity*

The changes in flow rates at Big Bear Spring over time are presented in Figure 14a. Little Bear Spring and Upper and Lower Tie Fork Springs are presented to show relationships with other HCIC water-right sources. Figure 14a also includes the Palmer Hydrologic Drought Index (PHDI) for Region 5. The PHDI is a drought index used to assess long-term moisture supply. It indicates the severity of a wet or dry spell, with negative values denoting a dry spell and positive values denoting a wet spell. Figure 14b shows Big Bear Spring and the PHDI, along with a chronology of significant mining events.

The most notable changes in the flow characteristics at Big Bear Spring are a marked decline in the size of seasonal peak flows and a drop in overall flow rate beginning in 1987 and 1988. There is an obvious correlation between the drought beginning in 1987 and the onset of these losses (Figure 14b). More contentious is the role mining might have had in these declines; however, a connection to mining has not been determined.

### *The Drought*

The drought, based on data presented for the PHDI in Region 5, began in 1987 and lasted until 1993 (Figure 14). Seasonal peak flows and total flow decreased at Little Bear and Big Bear Springs along with the drought index (Figure 14a). After 1990, the mean annual flow (obtained from the monthly means) did increase slightly for Big Bear Spring, but the magnitude of the increase in flow did not match the increase in the PHDI (Figure 15), and the seasonal peaks have never returned to pre-drought size.

The slow response to the end of the drought may result from a portion of the water, which would otherwise discharge at the springs, recharging storage drawn down during the drought, a type of hysteresis effect following the drought. Little Bear Spring is in a ground-water system that was unaffected by the Star Point Mine pumping or any other mining operations during this drought. In spite of the quick recovery of peak flows at Little Bear Spring following the end of the drought in 1993, the lowest flow at Little Bear Spring occurred in 1995, two years after the end of the drought (Figure 14a). This indicates the affect of the drought on water storage in the Little Bear Spring system extended beyond the actual drought period. The Little Bear low (April 1995) corresponds with the minimum flows reported for Big Bear (May 1995) and Upper Tie Fork Springs (May and June 1995), suggesting a similar extended response in those systems. In contrast, Lower Tie Fork Spring was out of synchronization with these other springs and had the highest recorded flow in May 1995.

### *Mine Water*

The response at Upper Tie Fork Spring to Star Point Mine's pumping at Gentry Ridge was anticipated and mitigated. Although the 1995 flow minimum at Big Bear Spring and the 1996 jump in flow correlate with the drought response at Little Bear Spring, the timing also suggests a component could be in response to the Star Point Mine pumping, which was at its greatest at the end of 1994 and dropped sharply in 1995 (Figure 1). Such a rapid response would further suggest the possibility of a direct hydrologic connection from the Gentry Ridge Horst –

Bear Canyon Graben area to Big Bear Spring, but existence of such a connection is not supported by any other information.

*Star Point Mine-water Interception*

***East of the Bear Canyon Fault***

Intercepted ground water averaged 150 gpm from April 1985 through 1986 at the Star Point Mine. Flows originated from longwall panels #3 and #12 (Map 3). Longwall panel #3 was initiated in August 1982 and ended in March 1986. This panel was centrally located in the series of longwall panels just east of the Bear Canyon Graben and on the west edge of the mining block. Intercepted flow peaked within longwall area #3 in September 1985. Development of longwall panel #12 in the Wattis Seam was conducted in 1989 and the longwall was pulled in 1990. Little information on flow at the #12 longwall panel was found in the Star Point Mine Plan. According to the mine maps, panel #12 is located near the subsidence that occurred under the North Fork of the Right Fork of Miller Creek and is not suspected to be related to changes at Big Bear Spring.

Water intercepted in the Star Point Mine in 1986 through 1987 averaged 218 gpm. During this period, longwall panels #4 and #5 in the Wattis Seam were mined adjacent to the Bear Canyon Fault. A surface subsidence fracture occurred above panel #4 that may have contributed inflow from the surface and formations above the coal. A decrease in peak flow was noted at Big Bear Spring in 1987, so timing suggests that the mining in panels #4 and #5 might have intercepted flow to Big Bear Spring.

However, fault related ground water was clearly encountered earlier (pre-1983), when the mine intercepted the east side of the Bear Canyon Fault at two locations: the 2<sup>nd</sup> Left (8,780 ft) and the 2<sup>nd</sup> West Mains (8,490 ft) in the Wattis Seam. Where the 2<sup>nd</sup> Left Main contacted the Bear Canyon Fault, initial inflow was 6 gpm from the roof. Liquefied gouge flowed from the faces of entries #2 and #3, extending approximately 10 to 15 feet into the entries after three weeks. Underground drilling in the #1 entry penetrated 40 to 60 feet of gouge and fractured rock before tapping into what was called "a significant conduit". Inflow from the drill holes peaked at about 150 gpm, dropping to 50 gpm in two weeks, less than 10 gpm after 10 weeks, and finally to zero. The encounter on the east side of the fault in the 2<sup>nd</sup> West Mains produced an initial inflow rate of about 20 gpm from the roof. This flow reduced to less than 10 gpm after 4 weeks of exposure and eventually dropped to zero. Very little water was found at the actual face. (Star Point Mine Plan, pp. 700-11 and 700-12).

The Bear Canyon Fault and related fractures, at the level of the Blackhawk coal seams, contained perched water, and a thick section of gouge separated the east and west sides. Star Point Mine operations east of the fault would not have interrupted recharge or flow to Big Bear and other springs west of the fault.

### ***Bear Canyon Graben Crossing***

The rock tunnel crossing through the Bear Canyon Graben was developed in 1989. Based on the results of borings done from the surface and from the in-mine drilling described by Mr. Mercier, the water encountered in the graben crossing originates from perched systems associated with fractures. A hole bored from within the tunnels confirmed that the Star Point Sandstone potentiometric surface was 160 feet below the tunnel, at an elevation of approximately 8,300 ft (Star Point Mine Plan, pp. 700-10 through 700-12).

### ***Gentry Ridge***

Throughout the mining process, flow entered from the mine roof. Water also seeped through the floor in the 4<sup>th</sup> Right and 5<sup>th</sup> Right longwall panels, which were mined in 1992 and 1993. Inflows that were not associated with fracturing or faulting were relatively small. Some sections of the Gentry Ridge workings were noted to have damp conditions: 3<sup>rd</sup> South and 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> Right Mains had small wet areas on the floor. PMC personnel speculated that this was indicative of conditions that would be expected in an aquitard located beneath the water table, and felt that these wet conditions were consistent with forecasts made prior to entry into the Gentry Ridge area.

Smaller inflows were found in the 3<sup>rd</sup> South Mains, near the Western Boundary Fault of the Bear Canyon graben. Flow rates up to 50 gpm were reported 1992-1993, the size of these flows generally increasing as mining progressed to the south.

Larger inflows within the Star Point Mine have been where mine workings intercepted segments of the western boundary fault of the Gentry Ridge Horst, which is also the eastern boundary fault of the Pleasant Valley Graben and may be continuous with the Trail Canyon Fault to the south (Map 3). Two large flows from floor fractures were encountered at the far western end of the 3<sup>rd</sup> West Mains. Combined flow was 100 gpm in January 1992, dropping to 40 gpm by April 1992, and was dry by May 1998 (Star Point Mine Plan, page 700-63 and Sheet 728b). A roof fracture in the south mains for the second longwall panel (3<sup>rd</sup> Right Mains) flowed an estimated 100 gpm in April 1992, but this was dry by October 1993. Approximately 50 gpm was measured flowing from the roof in the south mains of the third longwall panel (4<sup>th</sup> Right Mains) in May 1992, but this also was dry by October 1993. As mining progressed down-dip, to the south, in 1993, flows of as much as 200 to 250 gpm were reported from the vicinity of the western boundary fault during development near the headwaters of Wild Cattle Hollow, but there are no additional data for these locations. Inflows were pumped from the mined section until late 1995 when longwall mining ceased. Subsequent to that time, mine waters inflows have begun to re-establish the local potentiometric surface in the Pleasant Valley graben. No measurements or levels are known.

### ***Bear Canyon Mine Water Inflows***

Previous mining at this site dated back to 1938, but there had been a hiatus of approximately 30 years before Co-Op began mining at the Bear Canyon Mine in 1982, in the Blind Canyon Seam. Flow has been measured sporadically at SBC-7, a sump just inside the

portals, in the old workings. Flow at SBC-7 was 18 gpm in March 1988 and generally remained at 16 to 19 gpm through November 1989. When monitored in February, May, and August 1990, water had ceased flowing at SBC-7, and after monitoring in November 1990 and February 1991, this site was considered dry and monitoring was discontinued. The first significant flow of water into the new workings of the Bear Canyon Mine was from the roof near the sump in the East Bleeders. Flow was first measured from the sump at SBC-8 in March 1988, varying between 18 to 22 gpm until February 1989. The water originated from faults and fractures and produced the largest volumes flowing into the mine during the early mining periods. The combined flow of SBC-7 and SBC-8 was 30 to 40 gpm up to November 1989, after which flow into the mine at these two locations became inconsistent and then ceased (Figure 6).

Other significant inflows, recorded at SBC-10 and SBC-9 (Figure 6), originated from the Blind Canyon channel sandstone. In August 1989, mining operations in the North Mains of the Bear Canyon Mine, in the Blind Canyon Seam, approached the margins of the channel sandstone in the mine roof. By November 1989, large roof drips began to flow into the mine in this area. Initial flows measured in February 1990 at SBC-9 were 120 gpm, and flows reached a maximum of 175 gpm in 1993 - 1994 (Figure 6). The increasing inflow in the North Mains corresponded with the onset of inconsistent and diminishing flows at SBC-7 and SBC-8.

In February 1992 monitoring began at SBC-10 in the 1<sup>st</sup> East entries: flow started at 250 gpm, and combined flow measured at SBC-9 and SBC-10 jumped to 382 gpm. Mining in the North Mains reached the main body of the sandstone in April 27, 1993, and SBC-9 was moved closer to the channel sandstone. Flows rapidly declined at SBC-10, dropping to approximately 25 gpm by 1994; however, from 1993 to 1995 combined flows were relatively stable at 150 to 200 gpm. SBC-10 became inaccessible in 1995. Flow at SBC-9 declined gradually from 1995 to 1999 and was 55 gpm when the area was sealed in November 1999. In 1997, water that is believed to be from the SBC-10 area began discharging from the gob at SBC-13: When monitoring ceased in February 2002, flow was averaging approximately 28 gpm and appeared to be slowly declining (Figure 6). The water now monitored at SBC-9a comes from various sources throughout the Blind Canyon and Hiawatha workings, but most probably still comes from the Blind Canyon channel sandstone.

Mining under Wild Horse Ridge is not expected to impact Big Bear or Birch Springs. Reasons for this conclusion are discussed on pages 130-132 of Appendix 7-J the Bear Canyon Mine plan:

- 1) Faults with as much offset as the Bear Canyon Fault, 200 to 250 feet, are typically filled with low permeability gouge, which prevents movement of water both across and along the fault plane. Fault gouge is visible in the Bear Canyon Fault where it is exposed near the head of Bear Canyon;
- 2.) Fractures adjacent to such large faults typically transmit water parallel to the fault plane, but the fractures on the east (Wild Horse Ridge) side of the fault will not have good hydraulic communication with the fractures on the west side because of the fault gouge;

- 3.) Recharge most likely occurs in areas where the Panther Tongue crops out, rather than vertically through overlying strata;
- 4.) Dip is to the southeast, and flow will be strongly influenced to move in the direction of dip, rather than to the southwest towards Big Bear Spring;
- 5.) The gouge in faults will further inhibit lateral movement towards the west and Big Bear Spring;
- 6.) Water quality in three springs east of the Bear Canyon Fault is significantly different than water in Big Bear Spring, again indicating no or poor hydraulic communication between the Wild Horse Ridge area east of the fault and Big Bear Spring.

#### Hiawatha Mine Water Inflows

The dates when water was intercepted near the Bear Canyon Fault are not given in the Bear Canyon Mine Plan. However, the mean residence time of water flowing from the vicinity of the fault in the Hiawatha Mine is older than that for waters from either the Bear Canyon Mine or Big Bear Spring (Table IV-4), indicating water intercepted near the Bear Canyon Fault in the Hiawatha Mine has not been flowing to either the mine or the spring.

#### **Big Bear Spring Compared to Other Springs**

Annual average flow from Big Bear Spring declined steeply from 1986 through 1990, then remained fairly constant until the 1995 low (Figure 15). Bear Canyon flows increased in 1996 but did not approach the pre-drought flow rates, and have generally declined since. CVSSD worked on the collection system at Big Bear Spring from January to March 2001 in an attempt to recover additional flow.

Big Bear, Little Bear, Upper Tie Fork, and Lower Tie Fork Springs had a historic low flow during 1995, but Birch Springs did not (Figures 14a and 11). Little Bear Spring showed a quick increase in flow following this low and recovered to pre-drought output. Upper Tie Fork also recovered to pre-drought conditions, but more slowly, probably because of the continued, although diminished, pumping at the Star Point Mine. Flow at Big Bear Spring increased after the 1995 low but remained below pre-drought levels. Lower Tie Fork reached a low three months after Upper Tie Fork (Figure 8), but data are insufficient to make any conclusions about the impact of either the drought or the Star Point pumping on this spring.

Of these springs, Little Bear Spring is farthest from mining at the Star Point and Bear Canyon Mines, yet it was the first of these springs to reach minimum flow in 1995. It is significant that Little Bear Spring flow was at a minimum during this 1995 period (Figure 14a and Table IV-5) because Little Bear Spring is in a separate hydrologic system from the Gentry Mountain springs: it is located on East Mountain, south of Huntington Canyon, and elevated well above the canyon floor. Recent geophysical and dye-tracer work done by CVSSD indicates

recharge is dominantly from Mill Fork Canyon, through the faults of the Roan Canyon Graben.

Although Big Bear and Upper Tie Fork Springs had minimum flows recorded in May and June 1995, Lower Tie Fork had its highest recorded flow in May 1995 (Figure 14a) and the water level in well 85-35-1 spiked (Figure 5a). Lower Tie Fork Spring reached a low in October 1995, five months after the May peak. All these extreme events occurred during dewatering of Gentry Ridge by the Star Point Mine. The correspondence of the 1995 extreme lows at Big Bear and Upper Tie Fork Springs with the low at Little Bear Spring (Figure 14a) indicates these lows were due to regional climatic influences. Climate and pumping do not explain the peaks observed at Lower Tie Fork Spring and well 85-35-1. Lower Tie Fork Spring responds independently from Upper Tie Fork Spring, indicating separate flow paths and possibly separate recharge zones for these two springs, even though they are near each other and no fault has been identified between them.

At Big Bear Spring, the 1995 flow minimum and the 1996 jump in flow correlate with the drought response at Little Bear Spring. They also coincide with the pumping induced minimum and recovery at Upper Tie Fork. This suggests a component of the changes at Big Bear Spring could be in response to the Star Point Mine pumping, which was at its greatest at the end of 1994 and dropped sharply in 1995 (Figure 1), but no other information connects the Star Point pumping to the drawdown at Big Bear Spring. Such a rapid response would further suggest a fairly open hydrologic connection from the Gentry Ridge Horst – Bear Canyon Graben area to Big Bear Spring.

Spring – Source of Data	Historic Low Flow		Historic High Flow	
	Flow (gpm)	Month/Year	Flow (gpm)	Month/Year
Big Bear Spring – CVSSD	76	May 1995	378	July 1983
Upper Tie Fork Spring – CVSSD	39	May and June 1995	165	Aug 2002
Lower Tie Fork Spring – CVSSD	37	Aug 2002	147	May 1995
Little Bear Spring - CVSSD	195	Feb 2003	484	June 1998
Birch Spring - NEWUA	2.5	Nov 1994	100	Jan 1990
Birch Spring: other reported extreme flows (see Figure 11a).	15.8 (Co-Op at SBC-5 just prior to redevelopment of the spring in September. Reported flow in September was 0.5)	Aug 1998	230 (NEWUA via Star Point Mine: reliability of data not known)	Oct 1989 thru Jan 1990

*Water Quality*

The change in hydraulic conductivity in mined strata may change the residence time for water

traveling through the system. Data from the Big Bear Spring show a slight increase in TDS with time (Figure 16a), but this is probably related more to decrease in flow than to changes in residence time caused by mining (Figure 16b). TDS was generally lower during the high flow period before 1988 (Table IV-6 - Note: TDS was not determined during the highest flows during this period). TDS was higher than average during 1990 - 1991 and 1995 - 1996. The 1990 - 1991 increase in TDS corresponds to when Star Point Mine began mining under Gentry Ridge. It also roughly corresponds to when Bear Canyon Mine began discharging water intercepted in the mine in 1987 and then increased discharge beginning in 1991. The 1995 increase corresponds to the period when flows at several springs were at their lowest due to drought and when pumping from the Gentry Ridge Horst across the Bear Canyon Graben reached its maximum average monthly flow (Figure 1). The high value in 1999 is an unexplained single-point anomaly. No definitive conclusions can be drawn about the relationship between mining operations at the Star Point and Bear Canyon Mines and changes in TDS at Big Bear Spring, although some short-term increases do appear related to mining activities.

<b>Table IV-6: Big Bear Spring TDS</b>		
Average - 1980 to 1988	Average - 1989 to 2000	Historic Average 1971 2006
289	360	354

Data from Bear Canyon Mine and CVSSD.

The data presented by Bear Canyon and Star Point Mines show that Big Bear Spring water differs in oxygen and hydrogen isotopic-ratios in relation to the Meteoric Water Line (Figure 17). Big Bear Spring data plot below the Meteoric Water Line for the sample presented by Co-Op in 1995 and the data plot above the water line for the sample obtained by Star Point prior to 1991.

Water with an isotopic composition that plots below the meteoric water line is considered to be isotopically enriched, and that above is isotopically depleted. Isotopic enrichment or depletion may result from the climate at the time of precipitation, geochemical changes that have occurred in the subsurface, or both. The variation between the two Big Bear Spring samples may simply reflect seasonal changes. The data are insufficient to make a definitive interpretation.

### **Spring Sources with Wildlife and Agricultural Uses**

#### *Miller Creek Springs*

Springs 229, 232, 238, 492, 494, 500, 530, 753, 978, and S18-2 (Map 6) were monitored in association with USGS Water-Resources Investigations Report 95-4025 (Slaughter and others, 1995). These springs may have been affected by subsidence caused by longwall mining in the Star Point Mine (Map 3). Discharge from spring 500 diminished, following mining in the Wattis seam but prior to mining the Third Seam. Discharge from spring S18-2 diminished substantially about the same time and then became dry after June 1991. Spring 229 diminished in mid-summer, which is not unusual, but the spring did not regain measurable discharge after June

1989. Slaughter drew no definitive conclusion on the effect of mining subsidence on spring discharge.

Water quality in four springs did vary between pre-mining and post-mining data with slight increases in sulfate and slight decreases in bicarbonate recorded at springs 530, 238, 492, and 978 in 1992. No substantial variation in water quality was determined between the pre-mining and post-mining periods by the USGS study (Slaughter and others, 1995).

New springs may have developed below Gentry Ridge along the coal outcrops southeast and down dip from the mine sumps and well P86-01-TD (Figure 3). Water was pumped across the Bear Canyon Graben from the west into the Mother Goose sump in the Third Seam (Map 3). In a field visit to the Hiawatha Mine in 1997, UDOGM personnel noted that a considerable amount of water was flowing from seeps above and along the coal outcrops in the South Fork of Right Fork of Miller Creek. If these seeps and springs resulted from the pumping operations at the Star Point Mine they would have been expected to diminish after pumping operations ceased. No seeps or spring surveys were conducted in this region during or following pumping operations, and there was no follow-up visit.

#### *Gentry Ridge Springs*

On August 16, 1997, Lee McElprang, a private citizen concerned for the springs and water rights in the area, accompanied David Darby of UDOGM; Liane Mattson, Jeff DeFreest, and Charles Yankowitz of the USFS; and John Pappas of the Star Point Mine to observed springs in the Gentry Mountain region near Wild Cattle Hollow (Map 6). There is a concern that springs 424, 450, 452, 753, 971, 458, and 486 had been affected by mining subsidence. During this site visit the springs were flowing; however, it was raining the day of the visit so flow rates could not be measured accurately. It should be noted that some factors had changed by the time these springs were visited: 1) the drought period lasting through 1995 had ended, and 2) mine dewatering had ceased. Spring 971 east of the Bear Canyon Fault lies over longwall panels 4 and 5 where subsidence occurred (Map 3). This spring has been monitored on an irregular basis, since 1989. The only flow recorded was in May 1990; however, water-quality data were obtained on May 30, 1990 and July 15, 1991. This spring is roughly 1,200 feet above the Wattis Seam and was mined under in June 1987. From July 1987 through July 1988, longwall panels were mined in the Third Seam. This spring could have been directly affected by mining in the Wattis and Third Seams, but because there are no flow data prior to 1989, any impact of mining on the flow of this spring cannot be determined.

### **SURFACE-WATER RESOURCE HYDROLOGIC IMPACT ASSESSMENT**

Under this section, potential surface-water impacts are described first, then mine-water discharge information is discussed and finally data from drainages are reviewed for impacts associated with mining. This review focuses on the drainages with mine-water discharge or other identified potentials for impact.

### **POTENTIAL IMPACTS TO SURFACE-WATER QUALITY AND QUANTITY**

### **Water Quality - General**

Increases in TDS and sulfate are the most commonly observed changes in surface-water quality that result from mining in the CIA. These chemical changes are not often significant, because there is a large variability in TDS in the natural system and the water quality degrades downstream naturally. Mining may alter surface-water quality when surface water is re-routed and mine-water flows are discharged to the surface.

Re-routing surface water may change localized water quality by increasing the runoff retention time from a mine-site and decreasing sediment loading. The changes in peak flows and sediment load may increase or decrease stream competence and downstream channel aggregation or degradation.

Mining operations may change water quality due to contamination from acid- or toxic-forming materials, hydrocarbon and chemical contamination, other materials associated with mining such as rock-dust and road salting, increased sediment yield from disturbed areas, flooding and streamflow alteration.

Surface-water quantity changes include mine-water discharge, losses to stream flow through interception from subsidence, and diversion of surface water. Re-directing surface water may change localized flow characteristics, increase the detention time for runoff from a mine site, or may locally decrease or increase peak flows rates and flow velocities. Disturbed areas may increase the runoff volume and decrease infiltration, and sedimentation ponds may locally increase infiltration or evaporation rates. Mine-water discharges may be at constant or varied rates and be of sufficient volume to change the flow regimen. Subsidence holes or fractures that propagate to the surface may reduce or relocate stream flow or ephemeral flow. Subsidence induced landslides or rock fall may interrupt stream flow.

Streams within the CIA receive maximum flow rates in May through July in response to snowmelt runoff (Price and Plantz, 1987). Flows decrease significantly during the autumn and winter months. Summer thunderstorms may cause localized short-duration, high-intensity runoff.

### **Water Use**

The Price and San Rafael River Basins are primarily used for stock watering, farming, coal mining, electric power generation, and industrial purposes. Within the Castle Valley, agriculture and power production utilize nearly all of the in-flowing water (Mundorff, 1972). Flows in the gauged streams may occasionally approach zero. Storage reservoirs are common at higher elevations west and north of the CIA.

### **Minewater Discharge to Surface Waters**

The mine water discharged from the Bear Canyon and Hiawatha Mines as reported by the Utah Pollutant Discharge Elimination System (UPDES) Permit. Discharge Monitoring Reports

(DMR) are summarized in Table IV-7. Because the DMR data are sparse at some sites, operational monitoring discharge data from several of the same locations are included in Table IV-7. The Deer Creek Waste Rock and Burma Pond Sites and the Trail Canyon Mine do not have mine-water discharge. Not all monitored sites have provided data from a totalizing flow meter, therefore total flow volumes discharged from some mines are unknown.

<b>Table IV-7: Minewater Discharge, from UPDES Discharge Monitoring Report (DMR) and Operational Monitoring Data in UDOGM's Database</b>						
Mine (period of record)	Average Flow	Maximum Flow		Maximum Average Flow (DMRs only)		Reports of Zero Flow
	GPM	GPM	Date	GPM	Date	
Star Point Final Mine Discharge UPDES-011 (06/95 - 05/00)	14	150	Nov. 1996	150	Nov. 1996	11 Records Zero Flow - 9
Star Point Final Mine Discharge Operational (10/90 - 12/010)	0	0	-			111 Records Zero Flow - 111
Hiawatha Mohrland Portal Discharge UPDES-001 (5/91 - 2/02)	416	1,050	July 1994	1,050	July 1994	9 Records <sup>1</sup> Zero Flow - 0
Hiawatha Mohrland Portal Discharge Operational (1/79 - 6/06)	316	1,584	October 1993			320 Records Zero Flow - 31
Hiawatha Mine Discharge to Miller Cr. UPDES-002 (1/83 - 3/97)	13,244	149,306	May 1992	104,861	May 1992	8 Records <sup>2</sup> Zero Flow - 0
Hiawatha Mine Discharge to Miller Cr. Operational 1/83 - 3/97	182	1,221	May 1991			281 Records Zero Flow - 31
Hiawatha Mine Discharge - No. Fk Vent UPDES-010 (5/91 - 5/92)	1.0	2.1	May 1991	1.4	May 1991	3 Records <sup>3</sup> Zero Flow - 0
Hiawatha Mine Discharge - No. Fk Vent Operational (6/83 - 7/94)	2.6	14	May 1984			46 Records Zero Flow - 0
Hiawatha Mine Discharge - #6 Mine UPDES-013 (5/91 - 7/94)	0	0	-	0	-	9 Records Zero Flow - 9
Bear Canyon Mine Discharge to Bear Ck UPDES-004 (10/91 - 3/02)	121	350	Jan. 1992	318	Feb. 1992	106 Records Zero Flow - 0
Bear Canyon Mine Discharge to Bear Ck Operational (3/85 - 9/06)	73	318	February 92			315 Records Zero Flow - 98

1 UDOGM's database contains DMR data for only nine months, between May 1991 and February 2002.

2 UDOGM's database contains DMR data for only eight months, between May 1991 and November 1992. 3 UDOGM's database contains DMR data for only three months, between May 1991 and May 1992.

**THE SAN RAFAEL RIVER BASIN**

**Huntington Drainage**

*Nuck Woodward Creek and Little Park Canyon*

Cypress Plateau collected data at monitoring sites 78-10-2CV and 87-10-3CV on Nuck Woodward Creek, respectively above and below Little Park Canyon (Map 6), from June 1993 to September 2001. There were no obvious changes to the water quantity or quality through the monitored period. There are no discharges from mine sites to this drainage.

Mining in the Castle Valley Ridge area was designed to protect the channel in Little Park Canyon by leaving a block of coal beneath the channel. This channel was monitored during June, July, August, and September or October from 1993 to 2001 (87-10-1CV). Zero flow was reported at least once for each month during this monitoring period. No subsidence was recorded for this area.

*Bear Creek*

*Water Quantity*

Stream flow in Bear Creek varies greatly depending on precipitation and runoff factors. Table IV-8 below summarizes Bear Creek flows and mine-water discharge. Mining artificially increased flows to the creek through mine-water discharge. Water continues to discharge to Bear Creek at UPDES UTG04006-004, although volumes have decreased since mining ceased in the #1 and #2 Mines. Figure 18 shows the difference between flows recorded in Bear Creek at BC-1 above the Bear Canyon Mine and BC-2 below the mine. It also shows the discharge from UTG04006-004, the Bear Canyon Mine-water discharge point. Before significant discharge from the mine began, flows above and below the mine were similar. The larger flow downstream at BC-2 from 1991 through 1999 can be attributed to the Bear Canyon Mine discharge. Since 2000, upstream and downstream flows are again similar.

The #1 and #2 Mines were sealed and the areas reclaimed in 2006. However, gravity drainage through the #1 Mine portal continues, and as of 2007 water was still being drawn from the mine-discharge line to provide water for culinary and surface-operation uses; future consumption is not expected to decrease natural streamflow rates.

Station	Before mine-water discharge Average 9/80 -3/91	During active discharge Average 4/91 - 12/99	After active discharge Average 2/00 - 9/06
Upper Bear Creek BC-1	80	90	36
Lower Bear Creek BC-2	80	212	54
Mine-water Discharge UPDES Discharge Point UTG04006-004	0.2 gpm on 3/18/85 This is the only report from this period:	116	9

Because little water was encountered in the #2 Mine, water was pumped from the Blind Canyon Seam, reducing the discharge to Bear Creek. A waterline was installed from the Blind Canyon Seam up through a borehole to the Tank Seam.

*Water Quality*

Sediment

Total Suspended Solids (TSS) levels in Bear Creek above the Bear Canyon Mine are typically higher than below the mine (Table IV-9). Mine water is discharged into Bear Creek between the upper and lower sites. The mine discharge water contains considerably less TSS than the stream water and dilution is a factor in the decreases noted at the lower sampling location (BC-2). Additionally, the stream gradient decreases down canyon, reducing stream velocity and allowing suspended sediments to be deposited.

TSS at BC-1 (upstream) and BC-2 (downstream) average 2,347 and 2,265 mg/L. During precipitation events large amounts of sediment are transported in Bear Creek, thus large data ranges are observed for TSS. The maximum TSS for the BC-1 and BC-2 are 23,098 and 22,270 mg/L, respectively.

The TSS levels from the mine water DMR (UTG04006-004) are lower than stream background levels. Water in the mine is contained in sumps until settling allows discharge water to be in compliance with the mine's UPDES permit.

From a total of 132 TSS mine-water discharge samples collected as of June 2004, 79 samples have been below the detection limit. Average TSS of the remainder is 11 mg/L. The maximum mine-water discharge value recorded as 83 mg/L, which is much lower than the levels recorded for Bear Creek.

Station	Total Dissolved Solids (mg/L)		Total Suspended Solids (mg/L)	
	Average	Maximum	Average	Maximum
Upper Bear Creek BC-1	509 (11/84 - 11/06)	3,200	2,347 (09/80 - 11/06)	23,098
Lower Bear Creek BC-2	469 (11/84 - 11/06)	3,310	2,265 (09/80 - 11/06)	22,270
Mine-water Discharge UTG04006-004	404 (04/91 - 06/04)	998	11 (04/91 - 06/04)	83

Data from UDOGM database.

The minewater discharge, containing little sediment, can increase the water's ability to transport sediment (competence). The increase in competence may increase degradation (down cutting) below the discharge point until equilibrium is reached; however, the potential for increased sediment transport is naturally decreased because the gradient decreases downstream from the mine-water discharge. This in turn can create a shallow stream channel that will need to adjust to the sediment loading.

According to Susan White, Reclamation Biologist with the UDOGM, Bear Creek does not support fish and is not considered a cold water fishery. It may support some cold water species of macro-invertebrates. Huntington Creek is a local cold water fishery and has a Class 3A state water-quality designation. Recreational use (Class 2) of Bear Creek is primarily from the neighboring Trail Canyon City residents. The increased mine flow would not negatively impact the recreation at this site.

#### Total Dissolved Solids

The Class 4 water-quality standard for TDS is 1,200 mg/L. The maximum TDS level in the Bear Canyon Mine water is 782 mg/L with an average concentration of 363 mg/L, which is less than TDS concentrations upstream. Mine-water TDS may decrease the natural water TDS at the downstream Bear Creek site.

#### Additional Quality Standards

Acid forming discharges are uncommon in the region and acid forming materials are not known to be extensive in Utah coal mines. Should the presence of pyrite in the mine area cause a decreased pH locally the mixing with higher pH waters in the system would result in localized affects in the permit area and is not likely to occur off the permit area due to downstream buffering.

### **THE PRICE RIVER BASIN**

#### **Sand Wash Drainage**

Potential discharges within the Sand Wash Drainage would come from two UPDES discharge points located at the south west end of the Hiawatha Mine (UT0023094-006A, and -007A). No discharge has been recorded for these sites.

#### **Mudwater Canyon**

Mudwater Canyon received mine discharge from the Star Point Mine, UT0023736-001 several years ago. This drainage is in an ephemeral system and impacts appear to have been minimal. Data from monitoring the UPDES parameters are summarized in the Star Point Mine Plan. Their table lists the recommended EPA standards for wildlife as taken from the EPA. The results from their table show the following:

- Iron, Manganese, and pH are well below EPA standards;
- Oil & Grease and Total Suspended Solids levels are low; and

- Levels have increased significantly in 1996, but the level discharged is still no higher than the receiving stream.

### **Fish Creek**

Some portions of the Fish Creek drainage along Wild Horse Ridge may be subsided. Because of the thickness and nature of the overburden, mining should not impact this drainage. Monitoring stations FC-1 through FC-8 were added to the Bear Canyon Mine plan to monitor water quality and quantity in the creek.

### **Miller Creek Drainage**

The direction of surface water movement is from Star Point Ridge, east of the Bear Canyon Graben, is down-dip to the south-southeast, toward Miller Creek. Baseflow to Miller Creek from the Star Point Sandstone was estimated to be on the order of 60 gpm, based on a stream survey conducted on the North Fork of the Right Fork of Miller Creek by Star Point Mine personnel. This survey is discussed on pages 700-22 and 700-23 of the Star Point Mine Plan, and locations M-1 through M-15 that are referred to in the following discussion are shown on Map 722.100d.

Significant baseflow occurs to North Fork of the Right Fork of Miller Creek where the stream crosses the Star Point Sandstone. Between the headwaters region and stream monitoring station ST-1, sulfate concentrations increase significantly.

TDS concentrations at ST-1 ranged from 240 mg/L to 1,472 mg/L over 10 years between August 1980 to September 1990 (Star Point Mine Plan). Specific conductance was 592 micro-mhos/cm at the head of the reach with the largest gain, and it doubled to 1,190 micro-mhos/cm at the bottom of the reach (Star Point's M-14 to M-15), indicating a significant inflow of poorer quality water.

### *Subsidence Impacts*

Longwall mining in the Wattis Seam began August 2, 1988 and ended April 26, 1990. The Third Seam was mined in December 1990 through November 3, 1991. The overburden thickness above the Wattis coal seam is about 300 to 500 feet. As a result of subsidence, three surface fractures - 8 inches, 4 feet and 7 feet wide - had occurred by August 1992. The following changes to the hydrology of the Right Fork of Miller Creek resulted from the longwall mining. (Slaughter and others, 1995):

- Intercepted surface flows occurred at two locations. Surface water was diverted into fractures;
- Debris slide/rockfall deposition associated with subsidence occurred in the North Fork of the Right Fork of Miller Creek;
- Intercepted water was discharged at a new location where the existing channel traversed the Star Point Sandstone below the coal seam (surface-water monitoring station M-8); and
- Water-quality changes downstream of the mining included increased TDS from 300 mg/L to

1,500 mg/L and changed from predominate ions of magnesium, calcium and bicarbonate to predominate ions of magnesium and sulfate.

#### *Intercepted Flows*

The two interceptions of surface flow occurred in the North Fork of the Right Fork of Miller Creek in Section 18, T. 15 S., R. 18 E. and in a side canyon to the North Fork of the Right Fork in Section 12 (Star Point Mine, 1996 Annual Report, Subsidence Monitoring Report). The 1996 Star Point Mine PHC quantified the loss to stream flow as ...the maximum potential loss to the base flow of the North Fork of the Right Fork of Miller Creek is less than nine gpm .

The subsidence features in the North Fork Right Fork of Miller Creek located in Section 18 are associated with fractures. The stream water was diverted into the mine near subsidence monitoring point GS-1 in 1989. The subsidence affected a section of the stream approximately 800 feet long. (Star Point Mine, 1996 Annual Report, Subsidence Monitoring Report). The stream was diverted into the fractures at surface-water monitoring point M-6 in January or February 1989. At this location overburden is about 300 feet above the Wattis Coal Seam.

The side canyon to the North Fork of the Right Fork of Miller Creek, in the NW/4, Section 12, T. 15 S., R. 18 E., was diverted into the ground due to mining subsidence sometime between January 27 and April 27, 1989. It was again diverted at an upstream location in June 1990. Both surface-water interceptions occurred at sandstone-siltstone contacts. Overburden above the Wattis Seam is about 500 ft, at monitoring site M-3 (Slaughter and others, 1995) and subsidence was associated with known faults. Subsidence varied from hairline fractures to 6 inches and vertical displacement across the cracks varied from none to 2 feet. Width varied from hairline to about 2 feet. The cracks were fenced in the summer of 1991.

Beginning in July 1990, flow was observed in the section of the stream where flow had been previously intercepted. Flows have been observed during years with increased snow precipitation. These flows may suggest the fractures are healing. The Star Point Mine committed to collect additional data to determine if the fractures are healing (Star Point Mine, 1996 Annual Report, Subsidence Monitoring Report), but the outcome of those investigations is not known.

#### *Debris Slide/Rockfall Deposition*

In October or November 1988, a rock slide moved soil, rock, and vegetation into the North Fork of the Right Fork of Miller Creek. The debris slide, about 150 feet wide, originated in the Blackhawk Formation and Castlegate Sandstone. The movement of water through this debris could account for some of the changes in the chemical composition of the water that are discussed below.

#### *Subsidence and Surface-water Quantity Changes*

Streamflow appears to have increased through the stream reach traversing the Blackhawk Formation. Direct seepage to the stream from ground water is about 21 gpm; however, of the 15

gpm increase between measuring points M-6 and M-8, a substantial inflow is presumed to be derived from the Star Point Sandstone and a channel sandstone at the base of the Blackhawk Formation where the Hiawatha Coal Seam has been locally displaced. According to the Star Point Mine 1996 Annual Subsidence Monitoring Report, the increase in flow due to seepage from the system was anticipated from the Spring Canyon Member of the Star Point Sandstone. The water table identified within the Spring Canyon Member flows to the southeast toward Miller Creek. The remaining 12 gpm increase measured between M-2 and M-8 is believed to be derived from the saturated zone system of the Star Point Sandstone.

According to the Star Point Mine 1996 Annual Subsidence Monitoring Report, the loss in streamflow between measuring points M-9 and M-14 is believed to be due to flow from the stream into alluvial deposits that are present in the channel below station M-9. North Fork of the Right Fork of Miller Creek experiences a substantial gain in stream flow through the Storrs and Panther members of the Star Point Sandstone, based on a 49 gpm gain in flow between measuring points M-14 and M-15.

#### *Subsidence and Surface-water Quality Changes*

The most downstream point of impact to North Fork of the Right Fork of Miller Creek is at monitoring Site M-8. Selected water-quality parameters at this point were used to summarize the resulting change in water-quality characteristics to Miller Creek from mining subsidence. Water samples collected indicate the concentration of dissolved constituents increased from 310 to 799 mg/L between September and December 1988 and the type of water changed from magnesium calcium bicarbonate to magnesium sulfate. Dissolved solids increased to a maximum of 1,602 mg/L in July 1990 (Slaughter and others, 1995).

#### *Mine-water Discharge Surface-water Quality Changes*

The Hiawatha Mine surface facilities are located primarily within the Miller Creek Drainage. Numerous UPDES Discharge points are associated with the mine (UPDES Permit No. UT0023094). The following UPDES sites have no recorded discharge over the period of record:

-003	Upper Coal Storage Yard Pond
-004	Pond #4, North of Slurry Pond #1 (reclaimed-no longer exists)
-005	Pond #5, East of Slurry Pond #1.
-006	Pond #6, East of Slurry Pond #4.
-007	Pond #7 South East of Slurry Pond #5.
-008	Middle Fork Mine Yard.
-009	South Fork Mine Yard.
-011	Truck Loading Pond.
-013	Number 6 Mine-water tank overflow.

All these sites have a period of record from July 1994 through May 1991 except for site -013, which has a period of record from May 1991 through July 1994.

The information presented in Table IV-10 summarizes data for the three sites with recorded discharge to the Miller Creek Drainage. These sites include: The Hiawatha North Fork Ventilation Fan (UPDES UT0023094-010), a discharge valve on the Mohrland Pipe Line that is monitored when drained (UPDES-012), and the Miller Creek Mine-water Discharge (UPDES-002).

Mine-water discharges from UPDES No. UT0023094-002 through a pipe south of the Hiawatha Preparation Plant area, enters an underground culvert beneath the preparation plant, exits the culvert to the north of Refuse Pile #4, and finally drains to a tributary to Miller Creek. Iron coatings are observed at both the mine pipe and culvert discharge locations. To check for acid production, Bob Davidson and Susan White of UDOGM conducted sampling during a site visit on July 8, 1977. Although the mine water is acidified within the mine increasing the ferrous iron (Fe +2 ) concentration in solution, the contact with CO<sub>2</sub> and CaCO<sub>3</sub> raises the pH and results in Fe (OH)<sub>3</sub> deposition and pH within the 6.5 -9 limits.

<b>Table IV-10: Mine-water Discharges Reported by UPDES Discharge Monitoring Report</b>									
Hiawatha Mine-UPDES Permit No. UT0023094	North Fork Ventilation Fan UPDES-010			Hiawatha Complex Discharge UPDES-012			Hiawatha Miller Creek Mine-water Discharge UPDES-002		
	Max	Min	Avg.	Max	Min	Avg.	Max	Min	Avg.
Flow (gpm)	14	0.0	2.6	274	0.0	27.6	1,221	0.0	180
Field Specific Conductance umhos/cm	720	370	556	973	799	911	1,435	539	968
Field pH	8.4	6.7	7.8	8.11	6.8	7.4	7.6	5.0	7.2
TSS(mg/L)	63	0.5	6.3	14.0	4.0	9.4	60	.0.5	5.6
TDS(mg/L)	667	213	383	918	641	718	1,010	233	720
T-Iron (mg/L)	0.44	0.04	0.17	0.96	0.09	0.6	1.3	0.02.	0.15
Oil and Grease	4.4	0.4	2.0	1.6	1.2.	1.5	5.6	0.0	1.42

### Serviceberry Creek

A major portion of the mine facilities surround Sage Brush Canyon, a tributary to Serviceberry Creek. Both Sage Brush Creek and Serviceberry Creek function as ephemeral drainages (Map 6), the channels are usually dry except during rainstorms or when snow melts. The main stem of Serviceberry Creek has no water monitoring locations; however, water monitoring site 10-1 is located in Sage Brush Canyon. The site once had an average flow of 3.5 gpm and a maximum flow of 35.9 gpm. The source for these flows was the overflow from the

make-up water storage tank. The make-up water supplied the coal treatment plant and received water from mine discharge. When the tank overflowed it discharged into Sage Brush Creek under UPDES permit UTG-0040025-011, the mine labeled it monitoring site 011. Longwall operations ceased production in November 1996, all of Star Point's entries are closed (sealed) and backfilled. The Star Point Mine no longer discharges water as of January 2000. Three sedimentation ponds (Ponds 005, 006 and 009) and several small settling contain the runoff from the coal refuse pile. Ponds 005 and 009 and all the catch basins will be destroyed as coal refuse is removed from the piled. Pond 006 will be reclaimed to meet approximate original contour. Removal of the refuse by SCA will only benefit the area by reducing the volume of refuse and ensuring that it will never be exposed. All runoff will be controlled by alternate sediment control measures until vegetation is established and effluent standards to receiving streams are met.

The substitute soil stockpile is located in a Serviceberry Creek. All of the stockpiled material will be removed and the site regraded to AOC. The drainage on the site will be restored to transmit flows. As with the refuse pile alternate sediment control measures will be implemented to control sediment loading to receiving streams.

The area permitted by SCA lies within the Gentry CIA. No other potential impacts will take place than have already been identified in the CIA boundary, established before SCA acquired the refuse pile and subsoil stockpile.

### **Tie Fork Canyon**

Water-quality changes in Tie Fork Canyon may occur from changes in the water quality of Upper Tie Fork Spring. No surface-water quality monitoring sites are currently monitored in lower Tie Fork Drainage. Sites 34-1 and 34-2 are located near the Gentry Hollow and Wild Cattle Hollow confluence (Map 6). When the discharge from Upper Tie Fork is not diverted into CVSSD's collection system, it may change stream water quality because of its significant flow rate. Tie Fork Spring water characteristics are discussed in the section on Tie Fork Spring.

## V. MATERIAL DAMAGE CRITERIA

Material damage to the hydrologic balance is not defined directly in either the Utah or federal regulations.

The Utah Coal Mining Rules define material damage with respect to alluvial valley floors (AVF). "Materially Damage the Quantity or Quality of Water" means ... to degrade or reduce, by coal mining and reclamation operations, the water quantity or quality supplied to the alluvial valley floor to the extent that resulting changes would significantly decrease the capability of the alluvial valley floor to support agricultural activities.

For the purposes of R645-301-525, which addresses subsidence control plans, material damage means:

- (a) Any functional impairment of surface lands, features, structures or facilities;
- (b) Any physical change that has a significant adverse impact on the affected land's capability to support any current or reasonably foreseeable uses or causes significant loss in production or income; or
- (c) Any significant change in the condition, appearance or utility of any structure or facility from its pre-subsidence condition.

Criteria that are used to determine material damage to hydrologic resources in coal mining programs administered by other states or by the federal Office of Surface Mining (OSM) include:

- Actual or potential violation of water-quality criteria established by federal, state or local jurisdictions;
- Changes to the hydrologic balance that would significantly affect actual or potential uses as designated by the regulatory authority;
- Reduction, loss, impairment, or preclusion of the utility of the resource to an existing or potential water user;
- Short term (completion of reclamation and bond release) impairment of actual water uses that cannot be mitigated;
- Significant actual or potential degradation of quantity or quality of surface water or important aquifers; and
- Any situation that would create imminent danger to a person.

Key to applying these definitions in determining material damage to the hydrologic balance is determining what changes or impacts are significant and whether or not they can be mitigated.

## **MATERIAL DAMAGE CRITERIA - RELEVANT STANDARDS AGAINST WHICH PREDICTED IMPACTS CAN BE COMPARED**

The following criteria, alone or in-combination with other criteria, may be used to determine Material Damage and will be based on factors related to the use of a resource:

- Utah Department of Health Classification; waters in and adjacent to the CIA are classified as 1C -protected for domestic use with prior treatment, 3A- protected for cold water species of game fish and cold water aquatic life, and 4 - protected for agricultural uses;
- Water-quality Standards for waters of the State of Utah set by the Utah Department of Environmental Quality and the state Division of Water Quality (UDWQ, 2006);
- Primary (PDW) and secondary (SDW) drinking water standards set by the Division of Drinking Water in Rules for Public Drinking Water Systems, R309 (Utah Administrative Code);
- Water-quality standards, 40CFR Ch.1 Subpart 434.55, applies to underground mine-water drainage at Post-Mining Areas after best practicable control technology currently available is applied;
- Changes in water quality and quantity that cause irreparable impairment of use. These would be commensurate with identified land and water uses within and adjacent to the mine;
- Category 1 Waters within boundaries of a National Forest, with specific exceptions, are designated by the Utah Division of Water Quality as High Quality Waters and are subject to the state's anti-degradation policy to maintain water at the existing high quality. New point source discharges of wastewater, treated or otherwise, are prohibited (UDWQ, 2006, R317-2-3.2 and R317-2-12.1);
- The Utah Department of Environmental Quality, Division of Water Quality authorized discharge into surface waters under the Utah Pollutant Discharge Elimination System (UPDES); and
- Contamination, interruption, or diminution of a state appropriated water supply or water right.

Applicable UPDES standards are listed in Table V-I. Additional limits apply to each site and are reviewed and presented in detail if the limit is exceeded. Toxic pollutant discharge limitations apply, based on the occurrence, concentration levels, and discharging or placing wastes that produce an undesirable effect.

## **DAMAGE TO RESOURCES**

Hydrologic Impacts to the Upper Tie Fork Spring were mitigated by PMC through an agreement with the CVSSD and HCIC.

Available information does not definitively identify a cause for the decline in flow at Birch and Big Bear Springs. There are spring development and maintenance aspects that may have affected water quantity, but all of these, especially earlier ones, are not documented or

clearly understood.

The flow paths of ground water to Birch Spring and Big Bear Spring are not known in detail, but it is evident from the geology and topography that the source area is to the north, between the Bear Canyon Fault on the east and the Pleasant Valley Fault on the west, and that flow is dominantly through fractures. The potentiometric surface of the Spring Canyon Sandstone Member of the Star Point Sandstone is above the Blind Canyon Seam in the McCadden Hollow area, but the flows at Big Bear and Birch Springs are at the level of the Panther Sandstone Member, where the underlying Mancos Shale effectively stops any further downward infiltration. Mining operations in the Blind Canyon Seam in the McCadden Hollow area, should they occur, are not expected to intercept this deeper flow system or impact flows at Big Bear and Birch Springs. Mining operations east of the Bear Canyon Fault are not expected to impact of Birch, Big Bear, or Tie Fork Springs.

Utah Administrative Rule R645-301-728.340 requires a probable hydrologic consequences determination of whether underground coal mining and reclamation activities may result in contamination, diminution, or interruption of "State-appropriated Water in existence within the proposed permit or adjacent areas at the time the application is submitted." R645-301-731.530 requires the permittee to replace any such waters affected "...by UNDERGROUND COAL MINING AND RECLAMATION ACTIVITIES conducted after October 24, 1992, "

Hiawatha Coal Company supplied additional information and studies conducted to update their mine plan as defined by UDOGM in the permit renewal process. One factor reviewed was to identify the potential impacts from mining within the Hiawatha Mine Complex permit area to Big Bear Spring.

The Big Bear Spring flow hydrograph reflects high seasonal peak flows from 1980 to 1987 (Figure 14a). The PHDI shows those were also years with above normal wet conditions. Drought conditions from 1987 to 1993 could have contributed to the decrease in the peak flows. Flow at Little Bear Spring recovered fully after 1993 but the flow at Big Bear Spring did not return to pre-drought levels (Figure 14a). Mining has been considered among the possible influences to Big Bear Spring flow, but no conclusive connection has been made.

Big Bear Spring is located in Bear Canyon and within the Bear Canyon graben (Map 4). All mining conducted in the Hiawatha Complex mines took place east of Bear Canyon Fault and the graben (Maps 3a, 3b and 3c). Mining in the B Seam intercepted the Bear Canyon Fault at several locations, and most inflows to the mine were reported in the B Seam. Plate 7-22 of the Hiawatha Mine Plan shows inflow in 10<sup>th</sup> North that was very large, reported to be approximately 1,000 gpm when first contacted in the 1970's, then falling to 100 gpm over time.

Since the Hiawatha Mine closed in 1993, inflow locations and quantity are not completely known. Total mine discharge is measured at the Mohrland Portal. UDOGM's records indicate that U.S. Fuel was discharging mine water from Mohrland Portal from February 1979 to present (2007). Hiawatha Coal Company has committed to age date and characterize mine water inflows when the mine re-opens.

From the information presented on geology and ground water it is likely that the Bear Canyon Fault stores some water and acts as a barrier to ground water moving east or west. Hiawatha Coal Company recently supplied stratigraphic contour maps, Plates 6-6, 6-9 and 6-12 in the Hiawatha Mine Plan, which show that any drainage intercepted and directed into the mine would travel in a southwesterly direction. This is the reason for the discharge at the Mohrland portal. Flow from the Mohrland portal represents the total flow of ground water into the mine. Some water is known to be coming from the 10<sup>th</sup> West section of the King 4 Mine. Other flows are known to be coming from the older King 2 Mine, since it was used as a sump area at one time. Plate 7-1 of the Hiawatha Mine Plan identifies four areas in the mine where water flows into the mine. During the years Star Point was pumping water to their underground reservoir east of the Bear Canyon fault, the discharge at Mohrland increased (Figure 1). Water pumped from the Gentry Ridge Horst and sumped in the Star Point Mine, up dip of the Hiawatha Mine, seeped through the coal barriers between the mines and flowed out the Mohrland portal.

It appears from all information submitted by Hiawatha Coal Company that all mining that could intercept ground water along the Bear Canyon fault was completed prior to 1983. The information provided does not point to any specific cause for decreased flows to Big Bear Spring as far as mining within the Hiawatha Mine Complex is concerned.

Springs impacted by the subsidence occurring east of the North Fork of the Right Fork of Miller Creek were not specifically tied to a water right; therefore, no material damage was identified in association with these springs. Water was intercepted by the mine and is believed to re-issue downstream where new flow was documented.

## **DAMAGE TO SURFACE-WATER RESOURCES**

### **Miller Creek Drainage**

Water Right number 92-174 located on the Right Fork of Miller Creek is owned by U. S. Fuel Company and is reserved for industrial purposes (3.3 cfs). U.S. Fuel Company made an agreement with PMC to allow impacts due to mining. Prior to mining, the flows were around 6 gpm (Star Point Mine 1996 Annual Report, Subsidence Monitoring Report). Although surface-water quality and quantity changes occurred because of mining in the North Fork of Miller Creek, no determination was made by the Division of Water Resources or the State Department of Environmental Quality showing that changes to the hydrologic balance would significantly affect actual or potential uses. These waters were outside of the National Forest boundary and therefore were not subject to the anti-degradation policy that applies within the National Forest boundary. Although TDS and sulfate levels have increased there was no identified impairment of the designated use, thus no material damage has occurred.

## **SUBSIDENCE EFFECTS**

Noticeable cracks have occurred in the Blackhawk Formation where pillars have been pulled in both the Star Point and Bear Canyon Mines, in areas with a shallow overburden, and on narrow promontories and ridges with steep side slopes. As mitigation, some of these features were fenced to the satisfaction of the USFS. No material damage claim was identified in

association with this subsidence from the landowner (USFS).

Co-Op mined extensively in the head of Bear Canyon and in the southern portion of the ridge between Bear Canyon and Trail Canyon using room-and-pillar methods. This resulted in rock-falls and escarpment failures in both canyons. The most noticeable impact is on the west side of Bear Canyon where subsidence focused along a fault and produced a very visible scarp that cuts across the surface.

To date, longwall mining under Gentry Mountain has produced minimal subsidence impacts. Results have been similar on East Mountain, located south of Gentry. Tension fractures up to 6 inches wide are occasionally found around the margins of subsidence-panel, the larger cracks occurring at topographic features such as ridges and plateau margins. Subsidence can focus along a fault because tension cannot transfer across the fracture.

Table V-1: Mine-water Discharges Reported by UPDES Discharge Monitoring Report												
Limitations	Trail Canyon Mine-Bear Canyon Mine UPDES Permit UTG0040000			Star Point Mine UPDES Permit UT-0023736			Hiawatha Mine UPDES Permit UT0023094 - Not located within the Mine Plan. To be incorporated later.			PacifiCorp Deer Creek Coal Mine UPDES Permit UT0023604		
	6.5-9.0	7-Day	Daily Max	30-Day	7-Day	Daily Max	30-Day	7-Day	Daily Max	30-Day	7-Day	Daily Max
Field pH (range)	6.5-9.0											
Discharge	30-Day	7-Day	Daily Max	30-Day	7-Day	Daily Max	30-Day	7-Day	Daily Max	30-Day	7-Day	Daily Max
Flow (gpm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TSS (mg/L)	25	35	70	25	35	70	25	35	70	25	35	70
TDS	NA	NA	2,000 (lb/day)	NA	NA	2,000 (lb/day) *1,300	NA	NA	2,000 (lb/day)	NA	NA	2,000 (lb/day)
T-Iron (mg/L)	NA	NA	1.0	NA	NA	*2.0 (a)	NA	NA	1.0	NA	NA	1.0 (b)
Oil and Grease (mg/L)	NA	NA	10	NA	NA	10	NA	NA	10	NA	NA	10

a. Total Iron exceeding 2.0(mg/L) requires review of actions necessary to achieve compliance. No daily maximum will exceed 7 mg/L.

b. Total Iron standard may be approved if water-quality standard is not violated.

c. TDS limit applies to a total for all discharge points associated with this UPDES permit.

\* Applies to site 001.

## **VI. STATEMENT OF FINDINGS**

Since the inception of SMCRA, mining in the CIA has been conducted in accordance with applicable rules and without material damage to the hydrologic balance. Some post-SMCRA mining related impacts have been mitigated through agreements between the mine companies, water rights holders, and landowners. There is no evidence that state-appropriated water supplies for this area have been permanently diminished, contaminated, or interrupted by coal mining or reclamation operations.

The area west of the Bear Canyon Fault is of special concern because several springs located there provide public water supply. Past mining west of the Bear Canyon Fault has not resulted in material damage or significant impact to hydrologic resources. The temporary decline in flow at Upper Tie Fork Spring, caused by the pumping of large volumes of water from Star Point Mine workings west of the Bear Canyon Fault, was foreseen and satisfactorily mitigated. The Utah Board of Oil, Gas and Mining determined that evidence does not indicate a hydrologic connection between the Bear Canyon #1 and #2 Mines, located west of the Bear Canyon Fault, and Big Bear Spring and Birch Spring, and the Supreme Court of the State of Utah upheld that decision. The Board has also found that evidence does not connect decreased flow in Big Bear Spring or Birch Spring with subsidence or water interception east of the Bear Canyon Fault at the Hiawatha Complex.

The Permittee will monitor water at streams, springs, wells, and inflows within the mine. UDOGM will continue to assess water monitoring data and other information to identify any mining related changes and impacts to the hydrologic regime of the CIA.

Should there be diminution, contamination, or interruption of a state-appropriated water supply due to mining, Permittees have committed to replace those water supplies. In addition, in accordance with federal lease stipulation 21, the Permittee of the Bear Canyon Mine has committed to replace any impacted water resource on USFS managed lands that has been identified for protection. The Permittees hold shares in HCIC that could be transferred or retired to cover such impacts, but other options include use of guzzlers, wells, liners, grouting, or other available technologies to restore or replace an impacted water supply or water resource.

UDOGM has found no probability of material damage to the hydrologic balance from anticipated coal mining operations.

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## APPENDIX A

### WATER RESOURCE HYDROLOGIC IMPACT ASSESSMENT FIGURES

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## APPENDIX B

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**APPENDIX C**

UTAH DOGM FIELD REPORT and SUMMARY MEMO from CHARLES  
REYNOLDS REGARDING OCTOBER 15, 1998 INVESTIGATION of BIRCH  
SPRINGS and RELATED FAULTS and FRACTURES

**APPENDIX**

**APPENDIX D**

**HYDRAULIC PROPERTIES of STRATA in the  
WASATCH COAL FIELD, UTAH**

**HYDRAULIC PROPERTIES of STRATA in the  
WASATCH COAL FIELD, UTAH**

- Various methods were used to determine these values.
- Some tests determined hydraulic conductivity, others transmissivity. Thickness of the saturated interval is given with transmissivity values, and hydraulic conductivity has been calculated.
- For values determined in ft/day and ft<sup>2</sup>/day, conversions to cm/sec and cm<sup>2</sup>/sec are in parentheses.

cm/sec = hydraulic conductivity      cm<sup>2</sup>/sec = transmissivity  
ft/day = hydraulic conductivity      ft<sup>2</sup>/day = transmissivity

		Price River	North Horn	Blackhawk	Star Point
USGS Lab Measurements on Cores (Lines, 1985, Table 3)	17-6 27bda Horizontal			Ss 1.5x10 <sup>-2</sup> ft/day (~5.3x10 <sup>-6</sup> cm/sec)	
				Silt 9.3 x10 <sup>-8</sup> ft/day (~3.3x10 <sup>-11</sup> cm/sec)	
				Shale - impermeable	
				Ss 1.1 x10 <sup>-2</sup> ft/day (~3.9x10 <sup>-6</sup> cm/sec)	
				Shale 1.1 x10 <sup>-8</sup> ft/day (~3.9x10 <sup>-12</sup> cm/sec)	
				Silt 2.0 x10 <sup>-7</sup> ft/day (~7.0x10 <sup>-11</sup> cm/sec)	
					Ss 3.1 x10 <sup>-2</sup> ft/day (1.1x10 <sup>-5</sup> cm/sec)
	17-6 27bda Vertical				Ss 1.5 x10 <sup>-2</sup> ft/day (5.3x10 <sup>-6</sup> cm/sec)
				Ss 3.7x10 <sup>-3</sup> ft/day (~1.3x10 <sup>-6</sup> cm/sec)	
				Silt 1.2x10 <sup>-7</sup> ft/day (~4.2x10 <sup>-11</sup> cm/sec)	
				Shale - impermeable	
				Ss 3.9x10 <sup>-3</sup> ft/day (~1.4x10 <sup>-6</sup> cm/sec)	
				Shale - not measured	
				Silt 2.2x10 <sup>-6</sup> ft/day (~7.8x10 <sup>-10</sup> cm/sec)	
USGS Recovery or Drawdown Test (Lines, 1985, Table 4)	17-6 24dcd-1			2 ft <sup>2</sup> /day (180 ft interval) (2.2x10 <sup>-2</sup> cm <sup>2</sup> /sec ~ 3.9x10 <sup>-6</sup> cm/sec)	
	17-6 27bda-1			8 ft <sup>2</sup> /day (590 ft interval) (8.6 x10 <sup>-2</sup> cm <sup>2</sup> /sec ~ 4.8x10 <sup>-6</sup> cm/sec)	
					6 ft <sup>2</sup> /day (80 ft interval) (6.4 x10 <sup>-2</sup> cm <sup>2</sup> /sec ~ 2.6x10 <sup>-6</sup> cm/sec)

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		Price River	North Horn	Blackhawk	Star Point	
		17-6 28bad-2	0.8 ft <sup>2</sup> /day (50 ft interval) (8.6 x10 <sup>-3</sup> cm <sup>2</sup> /sec ~ 5.6x10 <sup>-6</sup> cm/sec)			
		17-6 34dda-1		10 ft <sup>2</sup> /day (45 ft interval) (1.1 x10 <sup>-1</sup> cm <sup>2</sup> /sec ~ 7.8x10 <sup>-5</sup> cm/sec)		
		18-6 4bac-1			0.7 ft <sup>2</sup> /day (15 ft interval) (7.5 x10 <sup>-3</sup> cm <sup>2</sup> /sec ~ 1.6x10 <sup>-5</sup> cm/sec)	
Genwal Mine Slug Tests	Genwal MRP	MW-1 (1987)			0.1 ft/day (3.5x10 <sup>-5</sup> cm/sec)	
		MW-4 (1992)			0.6 ft/day (2.1x10 <sup>-4</sup> cm/sec)	
		MW-5 (1992)			2.5 ft/day (8.8x10 <sup>-4</sup> cm/sec)	
	Mayo and Associates, 7 Nov 1997	MW-2 Spg Cyn (1997)				4.8 to 4.9x10 <sup>-8</sup> ft/sec (1.5x10 <sup>-6</sup> cm/sec)
		MW-6a Spg Cyn (1997)				4.4 to 5.9x10 <sup>-8</sup> ft/sec (1.3 to 1.8x10 <sup>-6</sup> cm/sec)
		MW-7 Spg Cyn (1997)				7.4x10 <sup>-8</sup> ft/sec (2.2x10 <sup>-6</sup> cm/sec)
		MW-6 Panther (1997)				6.2 to 7.4x10 <sup>-8</sup> ft/sec (1.9 to 2.2x10 <sup>-6</sup> cm/sec)
Trail Mountain Mine	TM-3				5.1x10 <sup>-3</sup> cm/sec	
Skyline Mine Hansen Associates, 1979, p. 85	Blackhawk coal			2.7x10 <sup>-8</sup> cm <sup>2</sup> /sec (~4.4x10 <sup>-6</sup> cm/sec)		
	Aberdeen Ss			2.5x10 <sup>-2</sup> cm <sup>2</sup> /sec (~2.5x10 <sup>-6</sup> cm/sec)		
Bear Canyon Mine Slug Tests Bear Canyon Mine Plan, App. 7-N, Section 4.0	Spring Cyn Tongue	DH-1A			12.9 ft <sup>2</sup> /day (88 ft interval) 1.4x10 <sup>-1</sup> cm <sup>2</sup> /sec (~5.1x10 <sup>-5</sup> cm/sec)	
		DH-2			1.2 ft <sup>2</sup> /day (103 ft interval) 1.3x10 <sup>-2</sup> cm <sup>2</sup> /sec (~4.2x10 <sup>-6</sup> cm/sec)	
		DH-3			3.8 ft <sup>2</sup> /day (65 ft interval) 4.0x10 <sup>-2</sup> cm <sup>2</sup> /sec (~2.0x10 <sup>-5</sup> cm/sec)	
		DH-4			29 ft <sup>2</sup> /day (178 ft interval) 3.1x10 <sup>-1</sup> cm <sup>2</sup> /sec (~5.7x10 <sup>-5</sup> cm/sec)	

**APPENDIX**

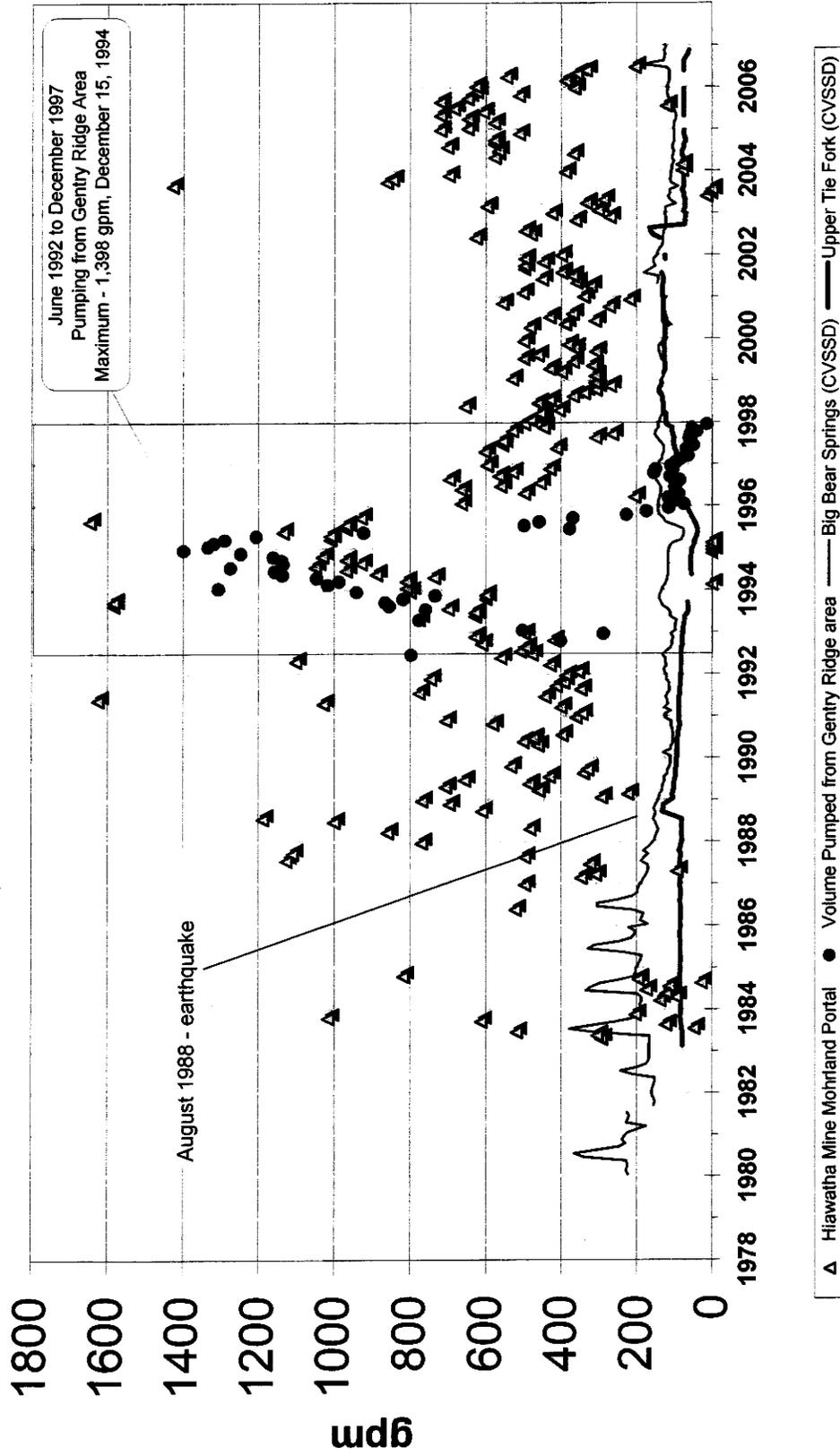
		Price River	North Horn	Blackhawk	Star Point
	Storrs Tongue	DH-1A			3.0 ft <sup>2</sup> /day (97 ft interval) 3.2x10 <sup>-2</sup> cm <sup>2</sup> /sec (~1.1x10 <sup>-5</sup> cm/sec)
		DH-2			-
		DH-3			0.07 ft <sup>2</sup> /day (87 ft interval) 7.5x10 <sup>-4</sup> cm <sup>2</sup> /sec (~2.8x10 <sup>-6</sup> cm/sec)
		DH-4			-
	Panther Tongue	DH-1A			51 ft <sup>2</sup> /day (70 ft interval) 5.5x10 <sup>-1</sup> cm <sup>2</sup> /sec (2.6x10 <sup>-4</sup> cm/sec)
		DH-2			2.2 ft <sup>2</sup> /day (88 ft interval) 2.4x10 <sup>-2</sup> cm <sup>2</sup> /sec (8.8x10 <sup>-6</sup> cm/sec)
		DH-3			6.9 ft <sup>2</sup> /day (72 ft interval) 7.4x10 <sup>-2</sup> cm <sup>2</sup> /sec (3.4x10 <sup>-5</sup> cm/sec)
		DH-4			-
Horizon Mine Palm Slug test and AQTESOLV		HZ-95-1			16.1 ft/day (5.7x10 <sup>-3</sup> cm/sec)
		HZ-95-1S	<u>alluvium</u> 20.7 ft/day (7.3x10 <sup>-3</sup> cm/sec)		
		HZ-95-2			0.25 ft/day (8.8x10 <sup>-5</sup> cm/sec)
		HZ-95-3			0.2 ft/day (7.1x10 <sup>-5</sup> cm/sec)
Mine Plan, Table		P92-01A-WD			2.35x10 <sup>14</sup> ft/day (8.1x10 <sup>-8</sup> cm/sec)

**APPENDIX**

---

		Price River	North Horn	Blackhawk	Star Point
Spring Cyn Tongue	P92-01B-WD			5.49x10 <sup>17</sup> ft/day (2x10 <sup>-10</sup> cm/sec)	
	P92-01C-WD				3.7 ft/day (1x10 <sup>-3</sup> cm/sec)
	P92-02-WD				0.44 ft/day (2x10 <sup>-4</sup> cm/sec)

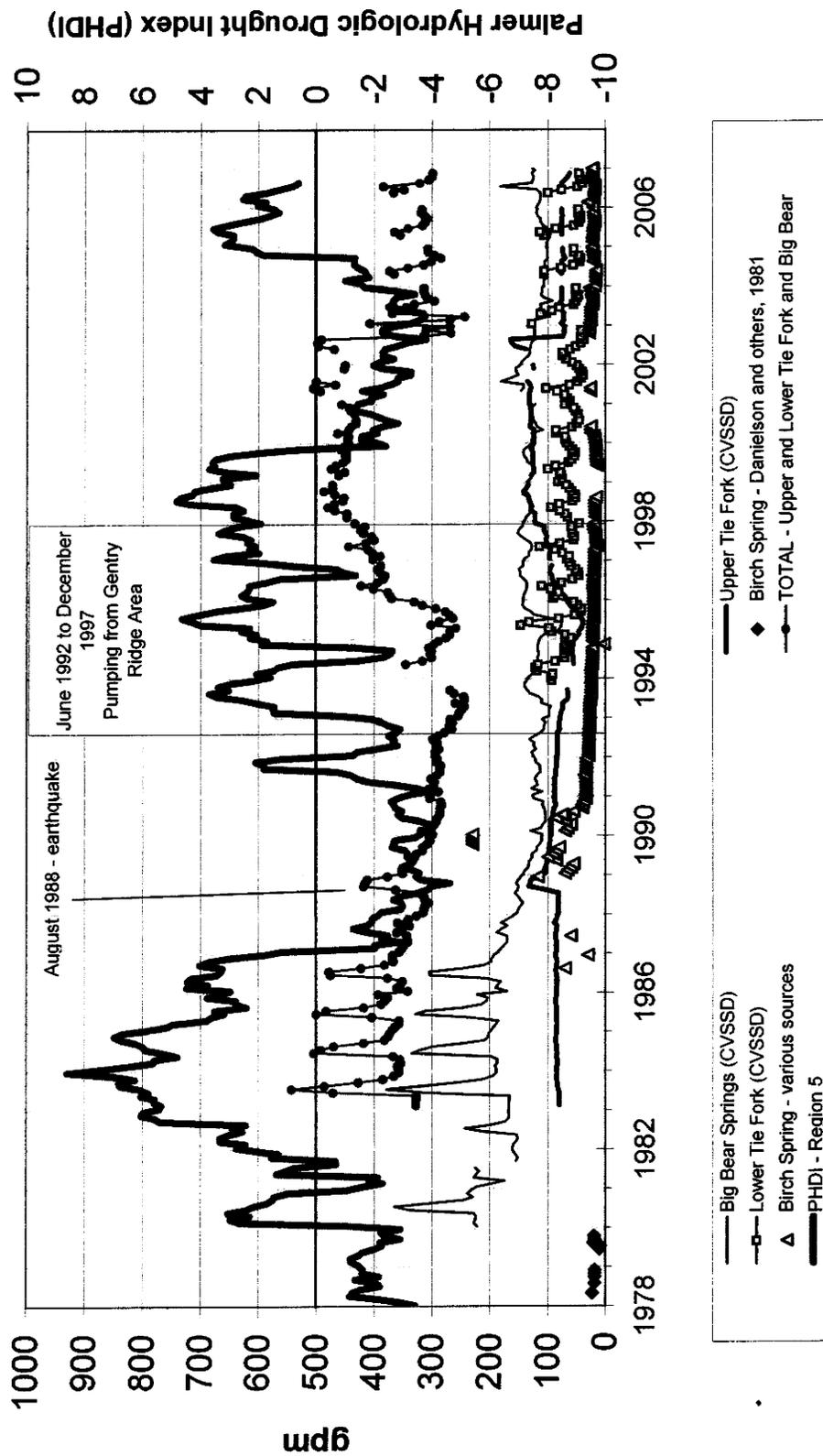
# Star Point Mine Pumping - Hiawatha Mine Discharge



Hiawatha Mine Mohrland Portal discharge is the total of the flows from UPDES UT0023094-001 and -002.

Figure 1

# Tie Fork, Big Bear, and Birch Springs



**Figure 2**



# Water Levels Under Gentry Ridge

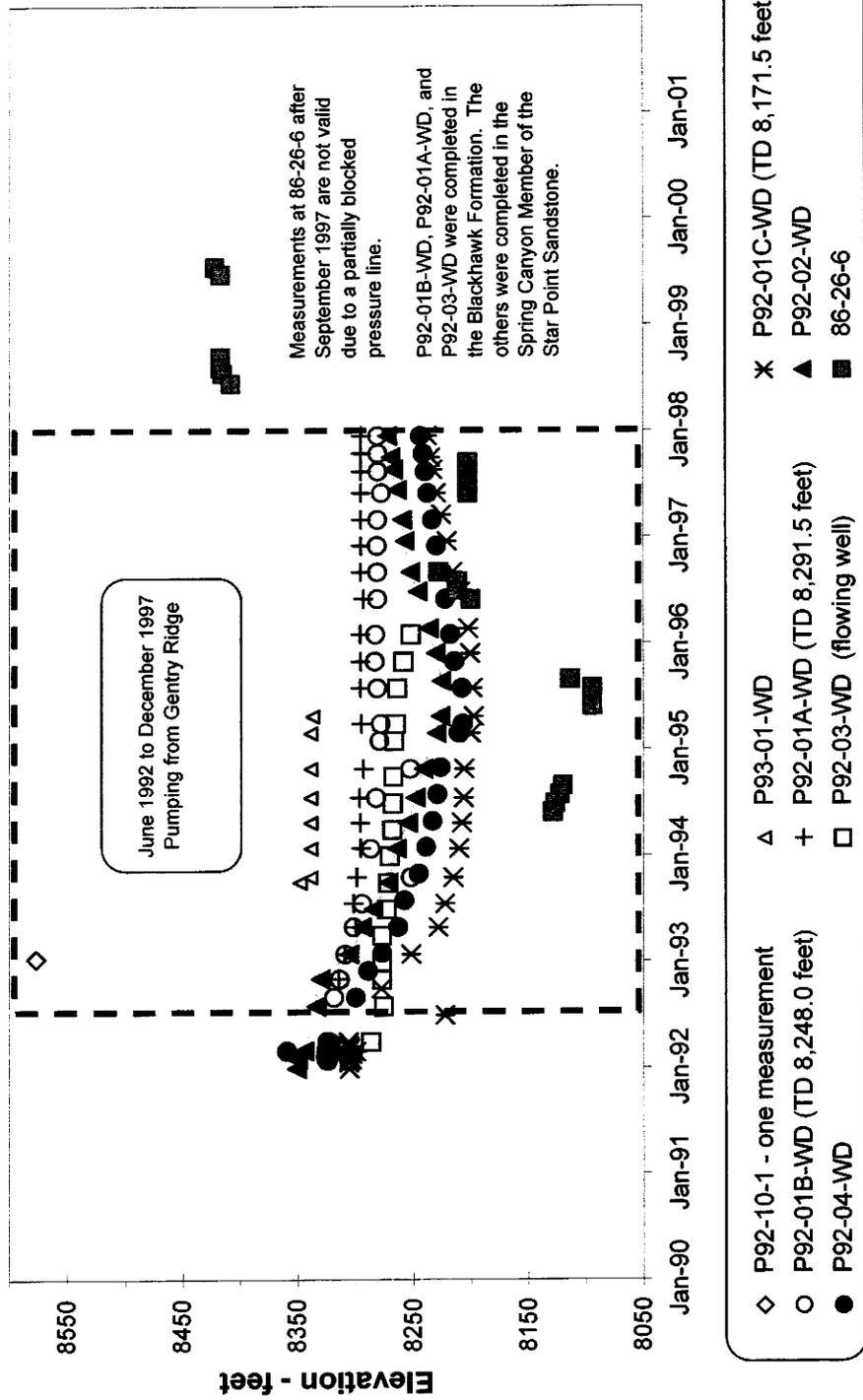
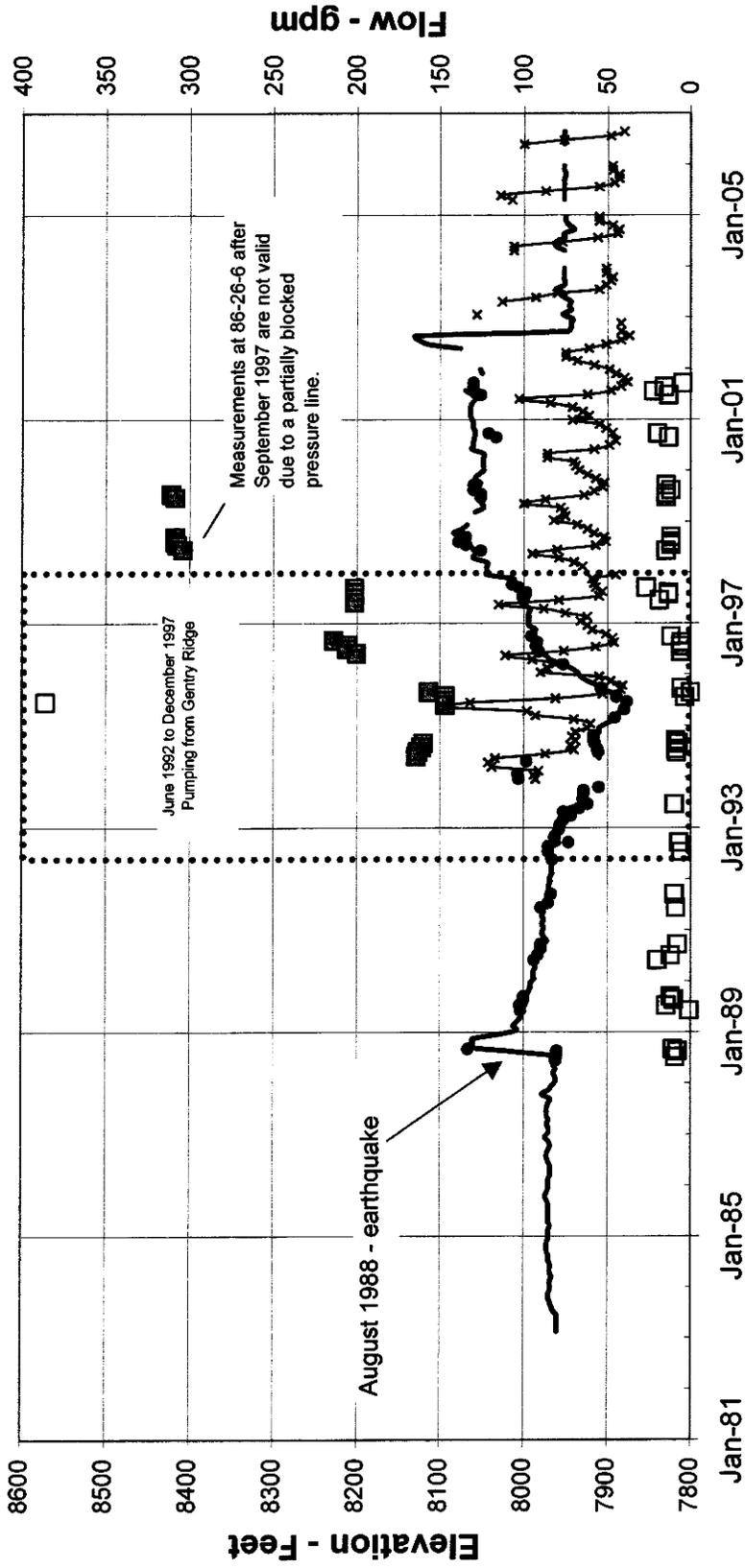


Figure 4a



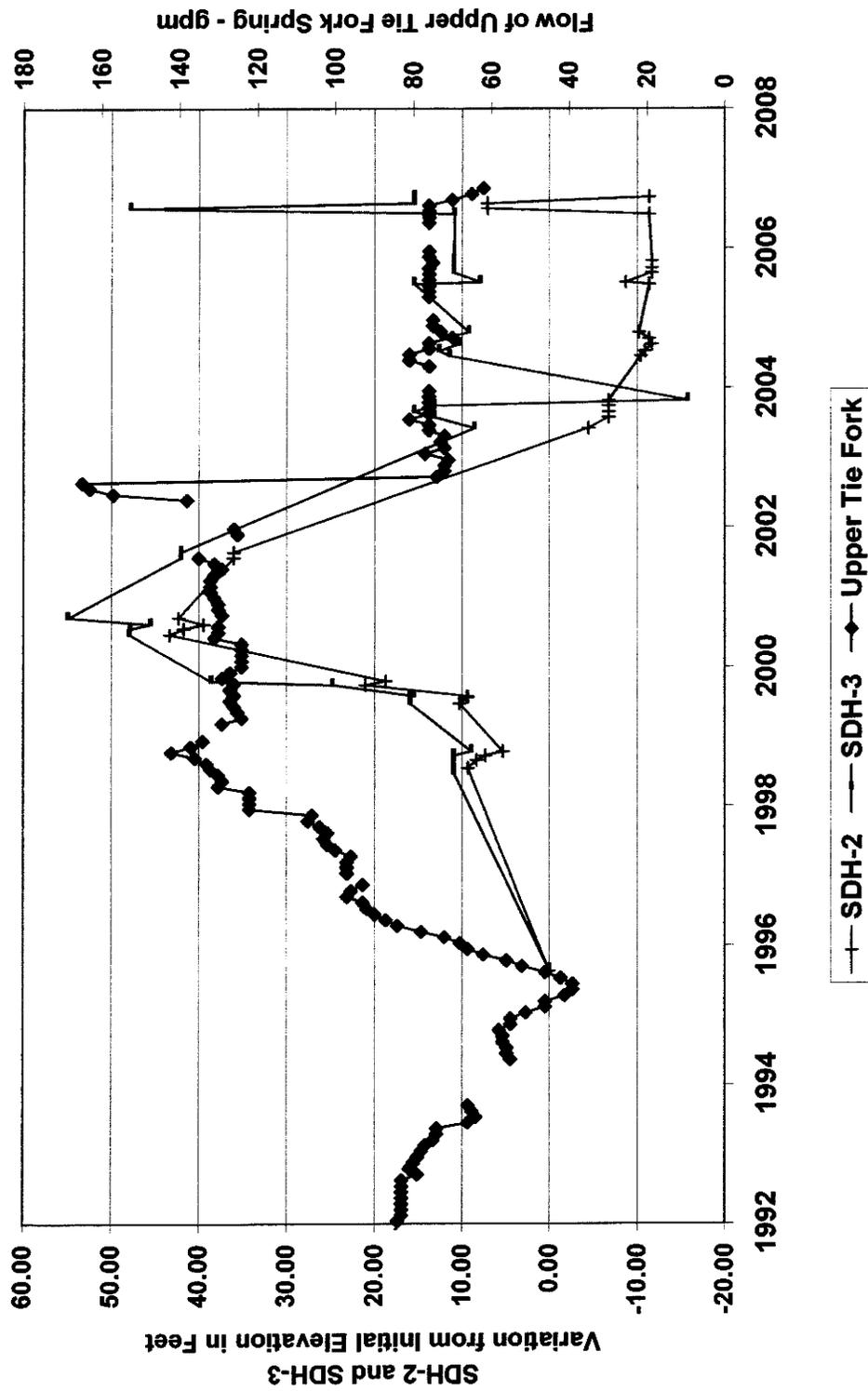
# UPPER and LOWER TIE FORK SPRINGS and Piezometer 86-26-6



■ 86-26-6 Elevation • 85-35-2-3 Flow □ 85-35-1 Flow — Upper Tie Fork Flow (CVSSD Data) — Lower Tie Fork Flow (CVSSD Data)

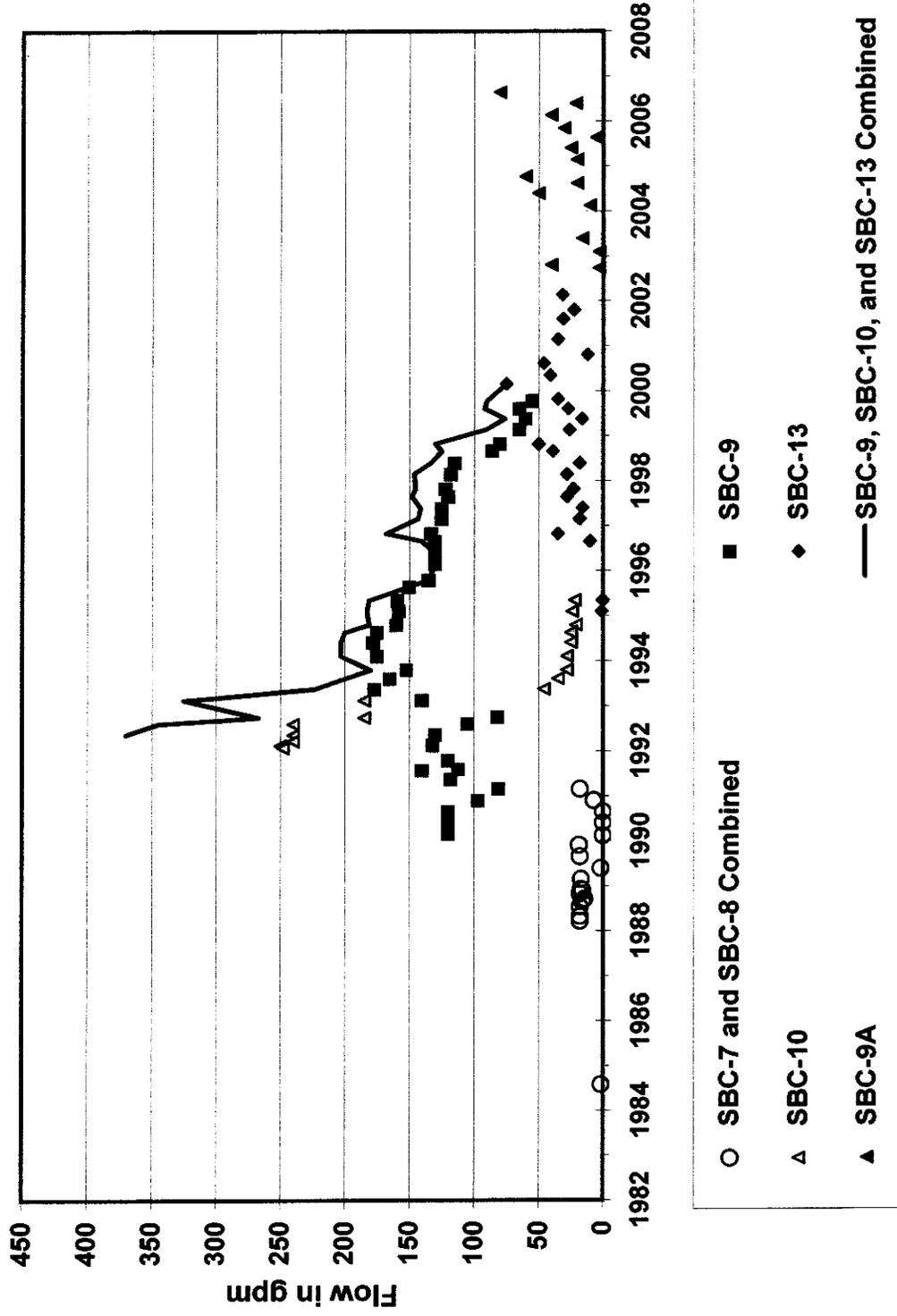
**Figure 5a**

# Flow at Upper Tie Fork Spring Compared to Water Levels at SDH-2 and SDH-3



**Figure 5b**

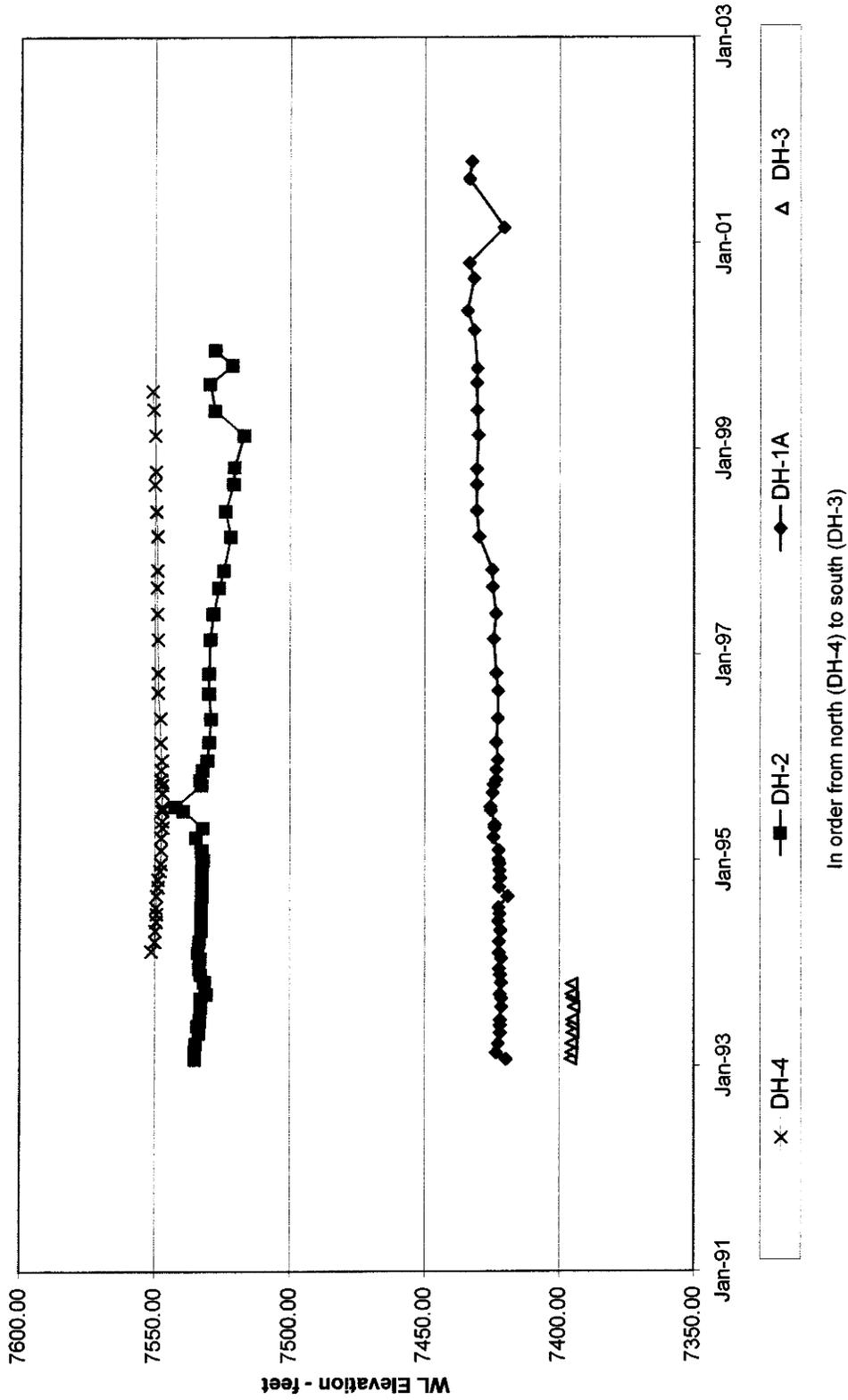
# Bear Canyon Mine In-Mine Flows



**Figure 6**

# Bear Canyon Mine: In-Mine Drill Holes

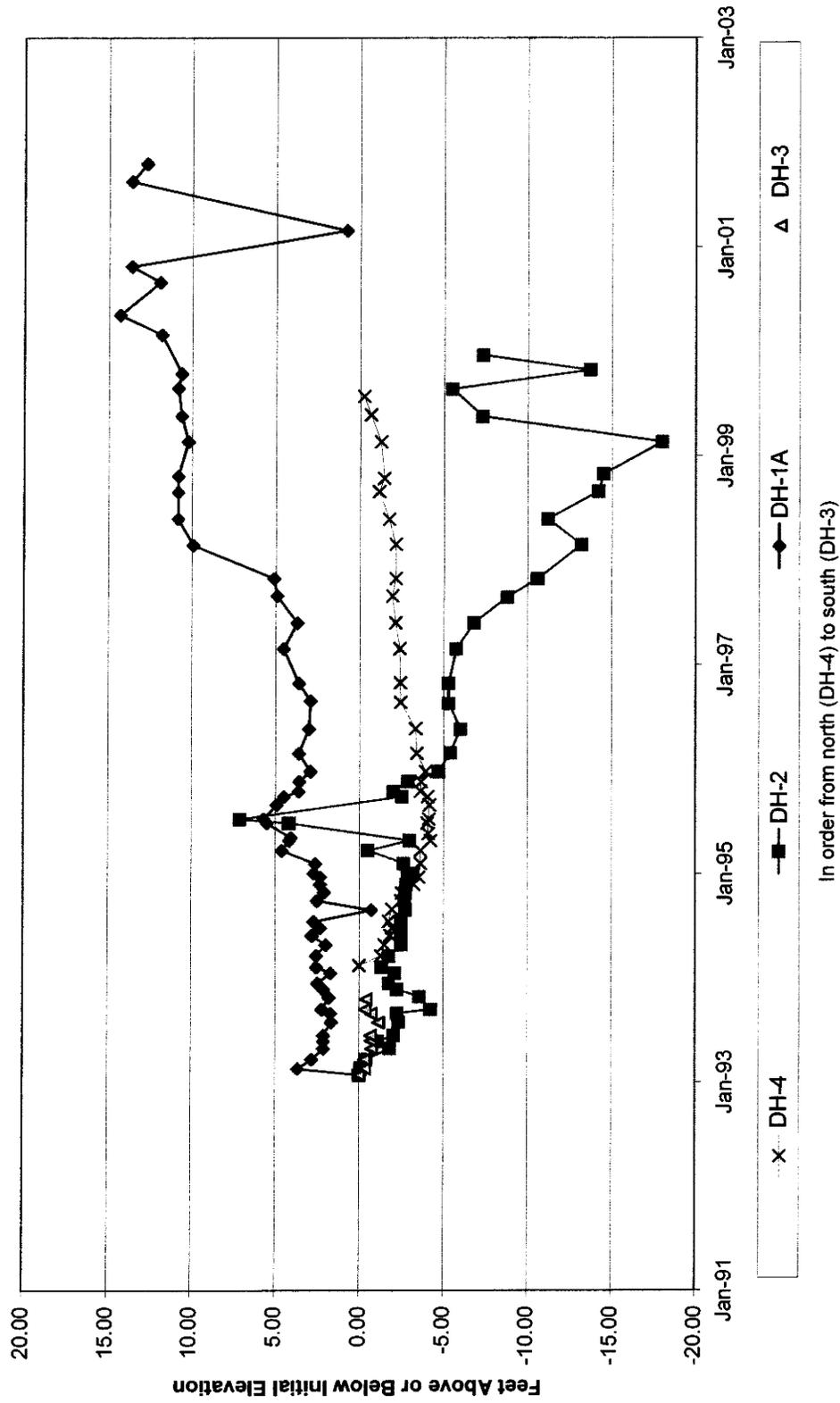
## Star Point Sandstone



**Figure 7a**

# Bear Canyon Mine: In-Mine Drill Holes

## Star Point Sandstone



**Figure 7b**

# Upper and Lower Tie Fork Springs and the Palmer Hydrologic Drought Index (PHDI)

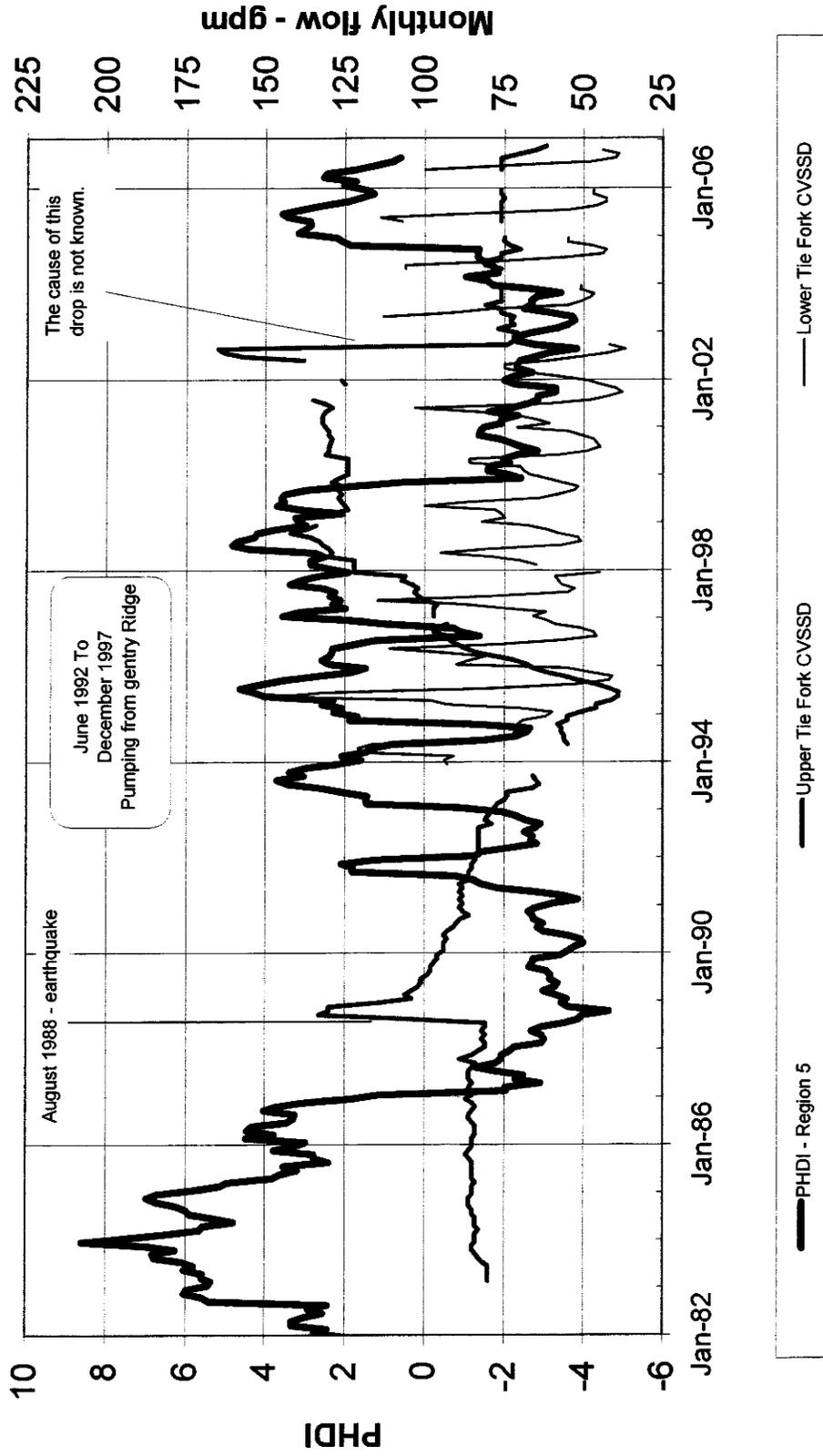
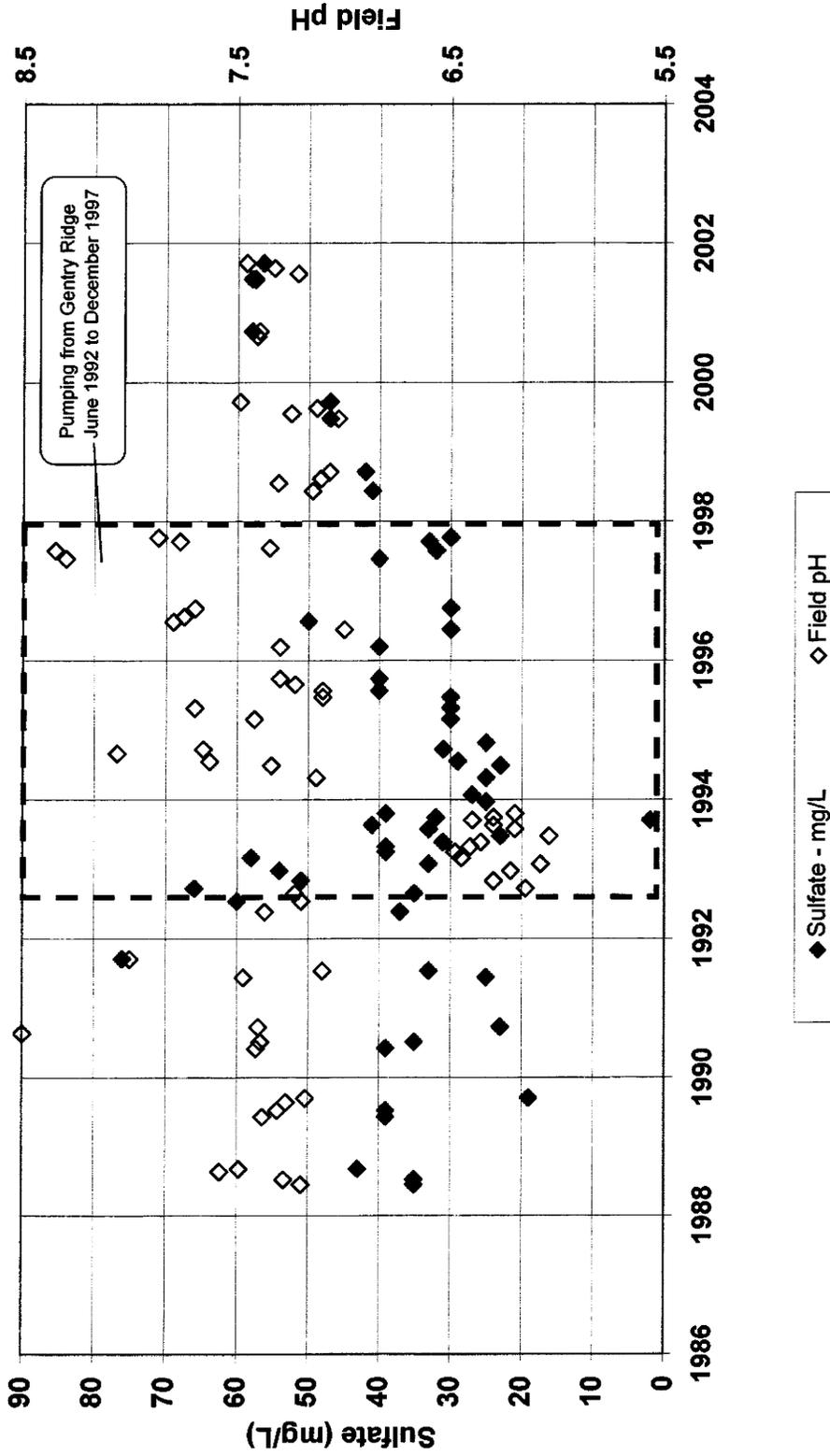


Figure 8

# Sulfate and Field pH

## Upper Tie Fork Spring (86-35-2-3)



**Figure 9a**

# Bicarbonate and TDS

## Upper Tie Fork Spring (86-35-2-3)

(Bicarbonate values adjusted to account for volatilization during dry residue TDS determination)

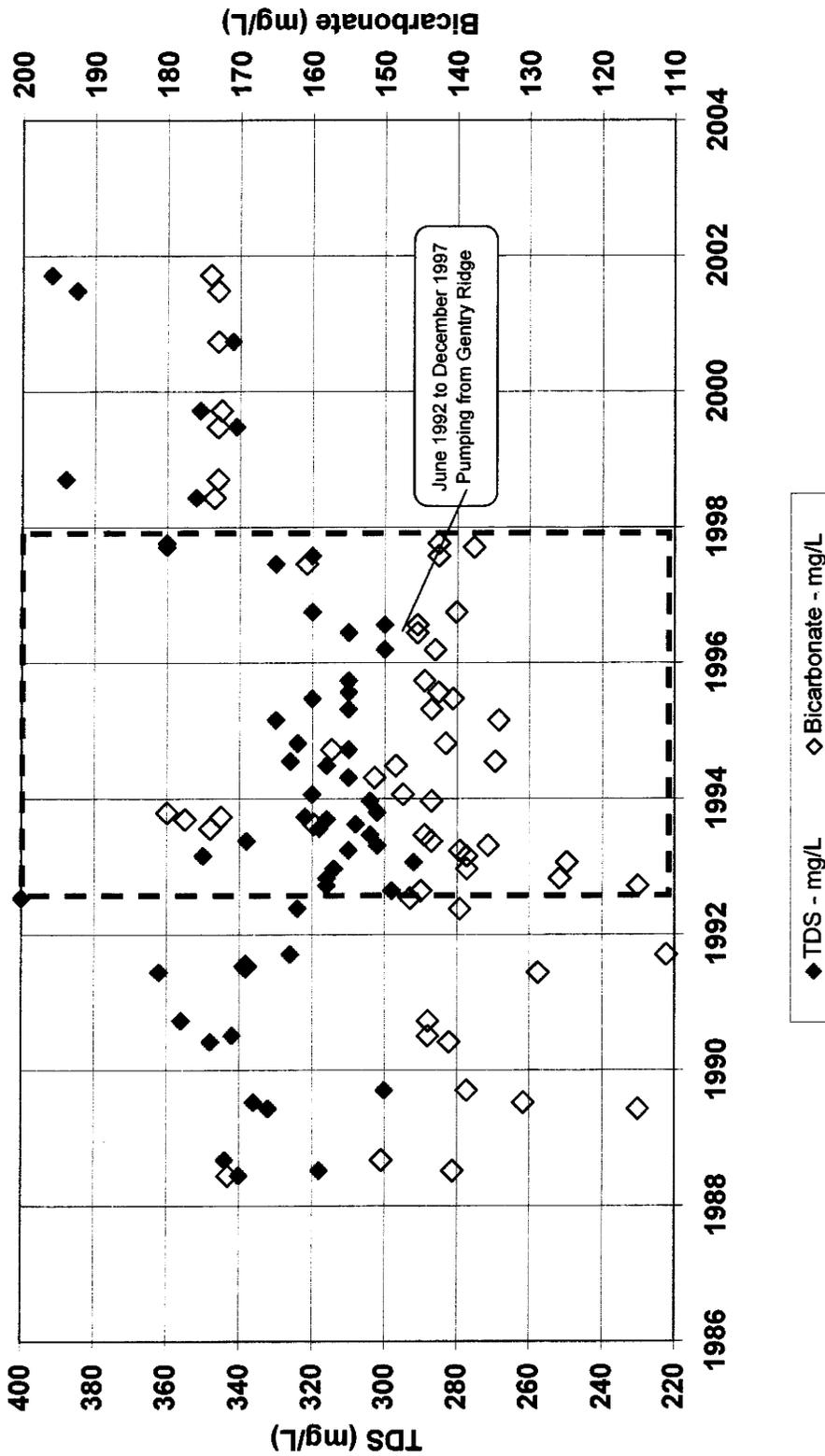


Figure 9b

# Bicarbonate and Sulfate vs TDS

## Upper Tie Fork Spring (86-35-2-3)

(Bicarbonate values adjusted to account for volatilization during dry residue TDS determination)

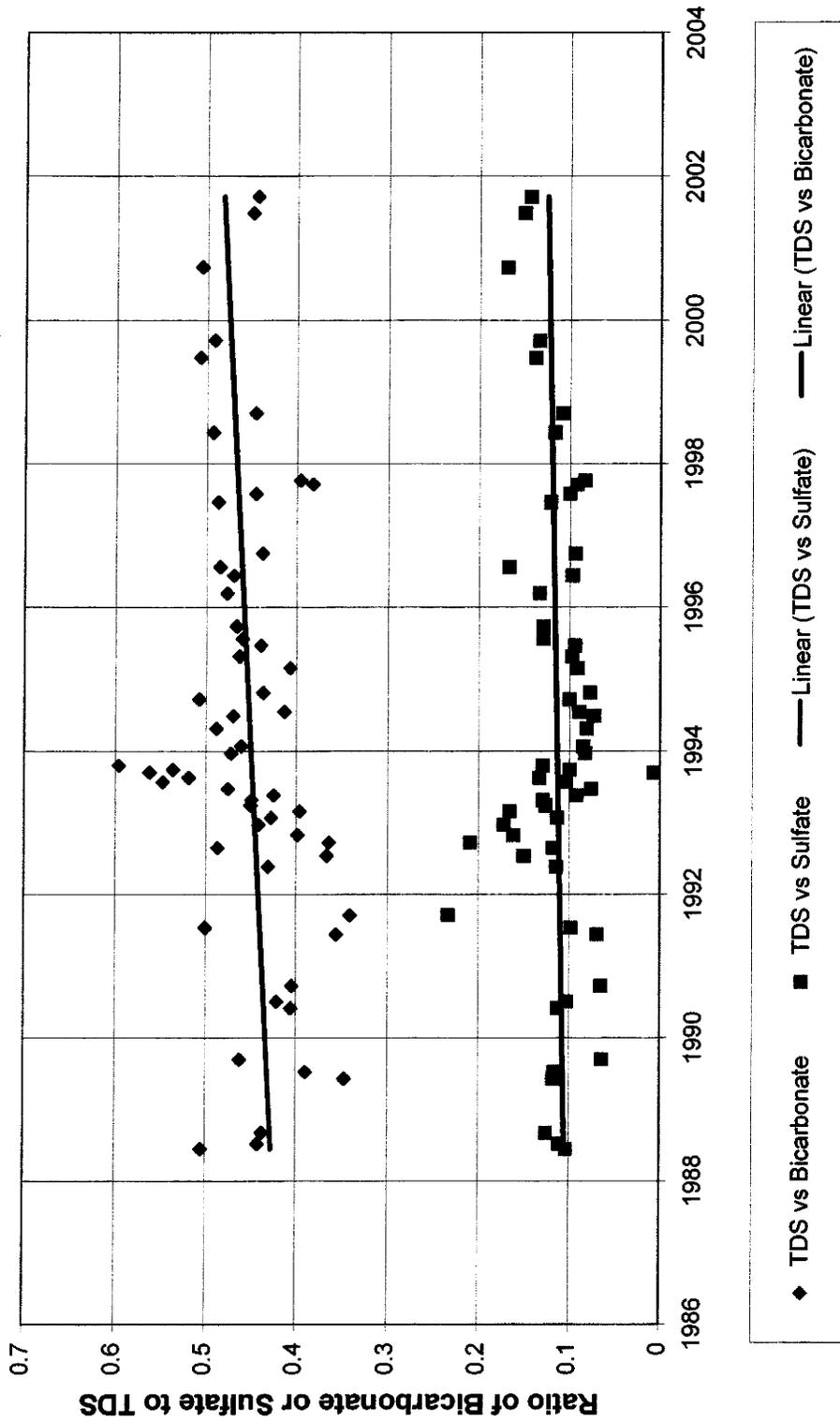
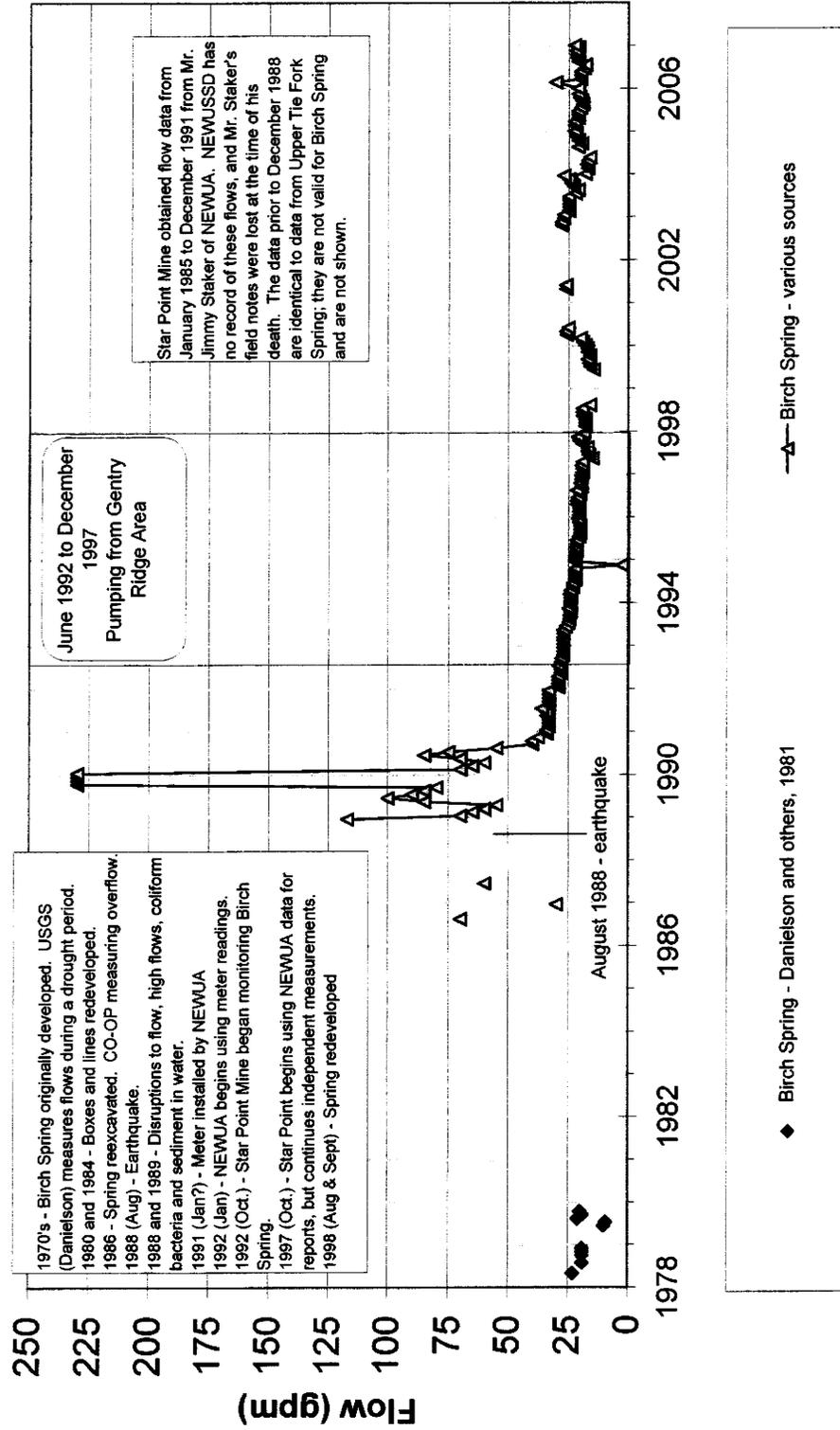


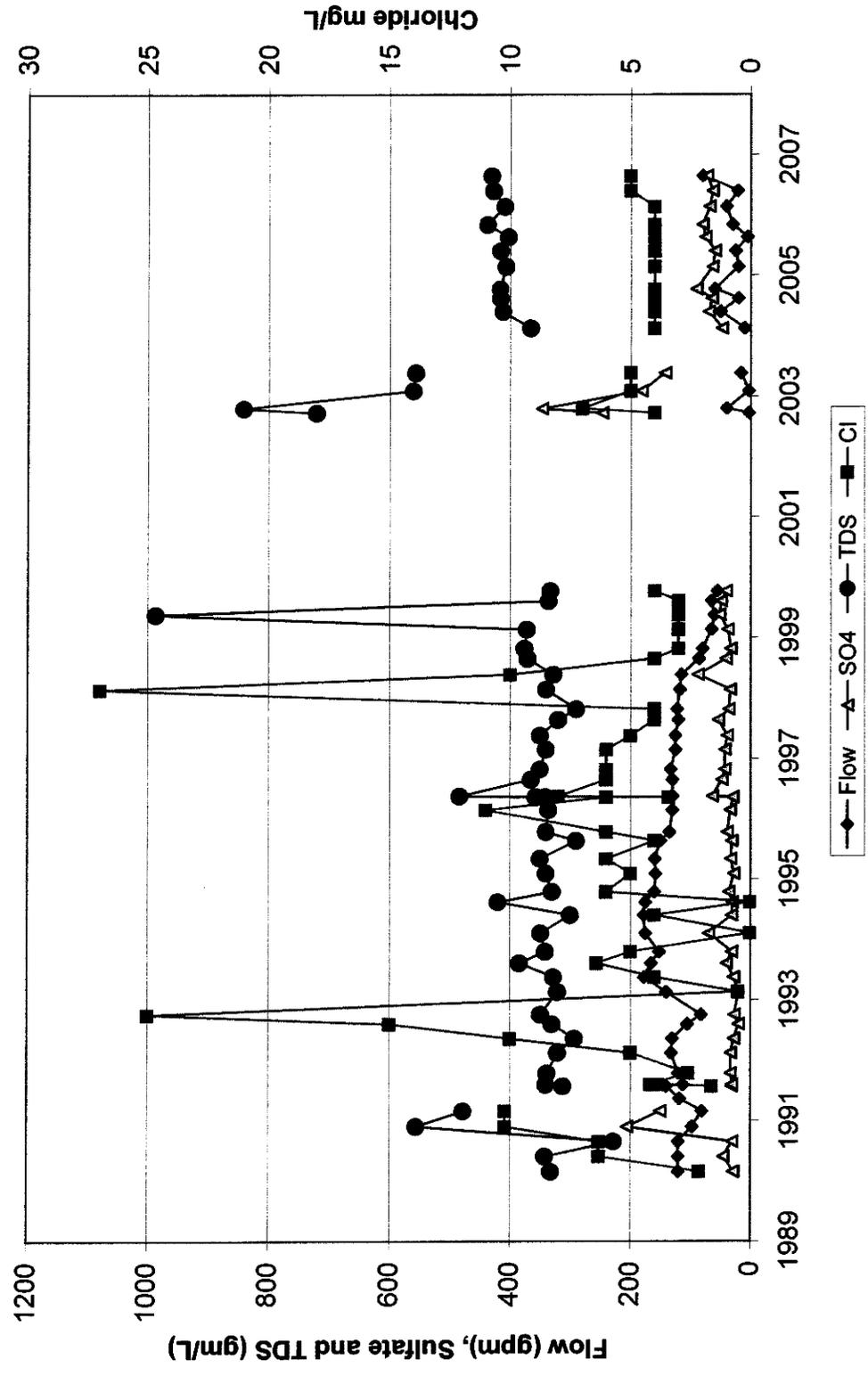
Figure 10

# Birch Spring Flow Combined Data Sources



**Figure 11**

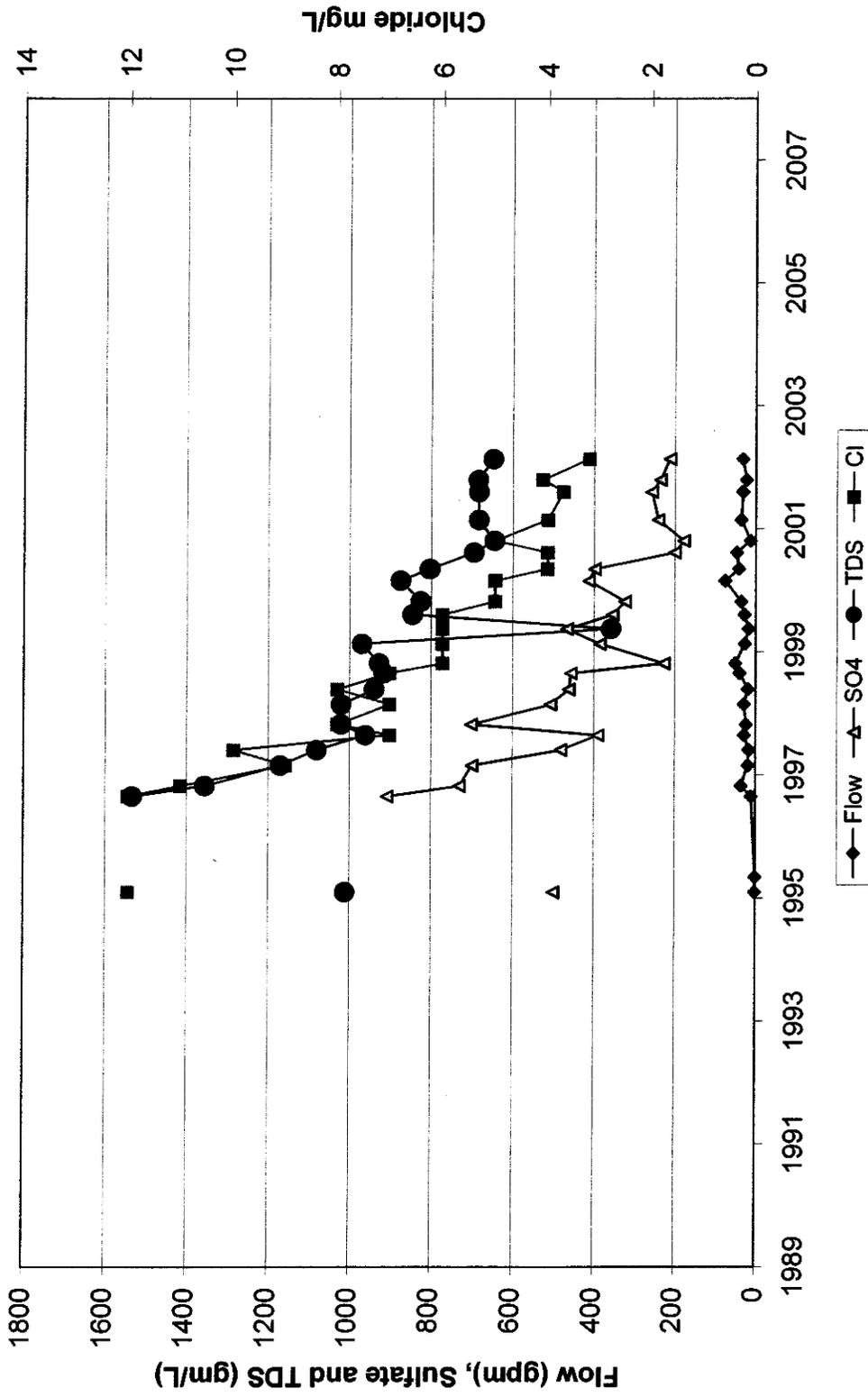
# Chemistry of SBC-9 and -9A Sand Channel



**Figure 12**



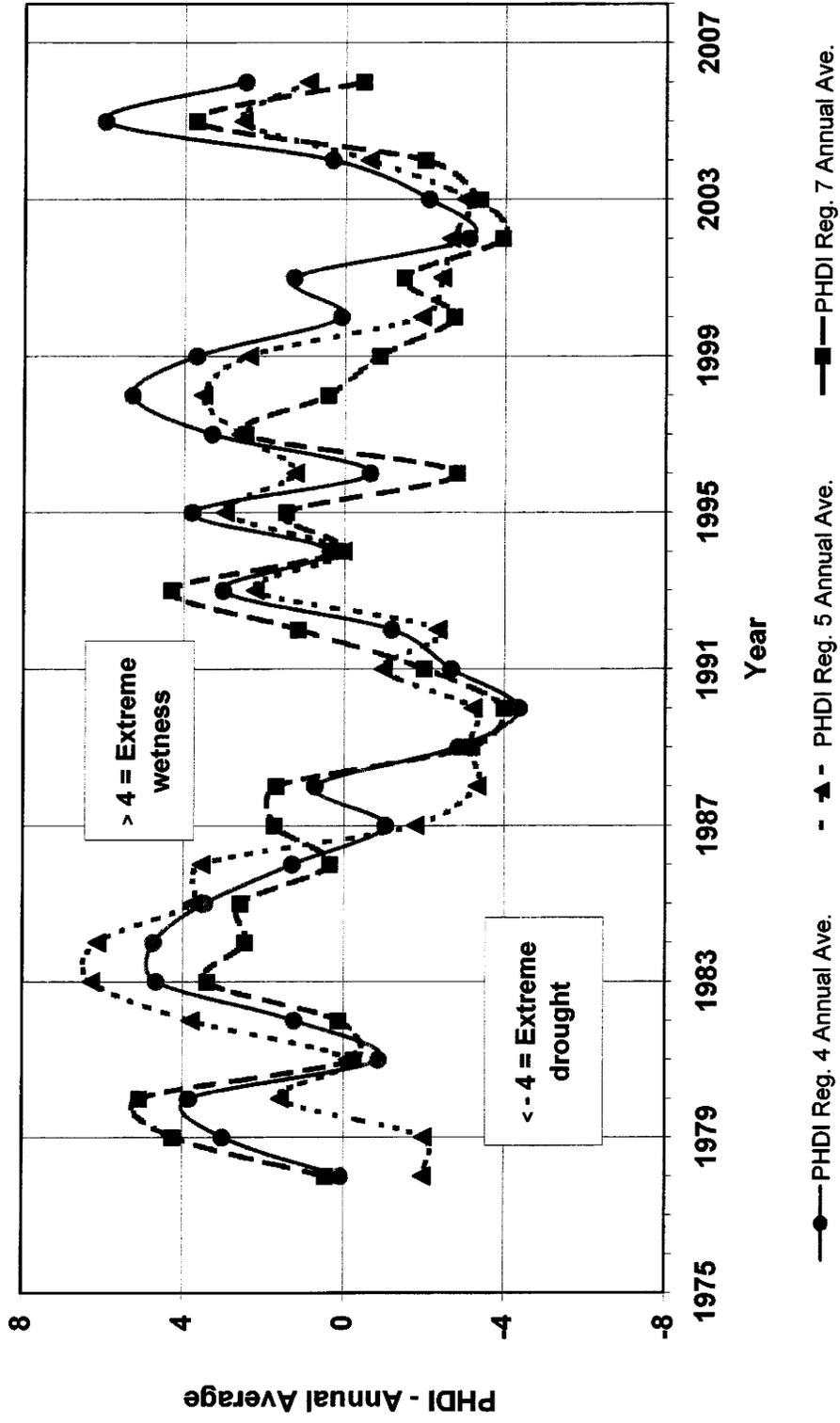
# Chemistry of SBC-13 Sand Channel



**Figure 13b**

# Palmer Hydrologic Drought Index - PHDI

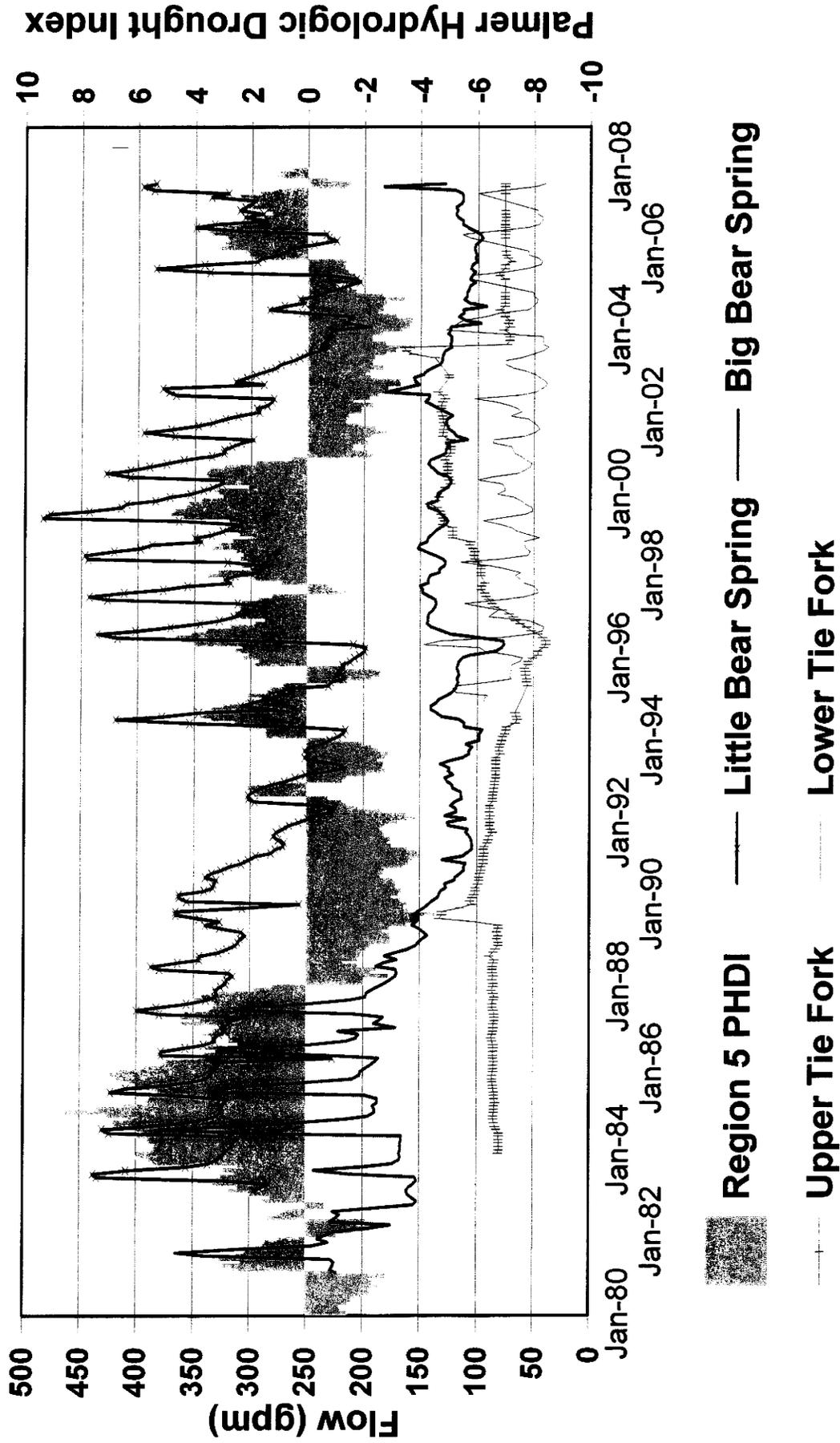
Utah Regions 4, 5, and 7 (Map 1a)



O:\CHIA\CHIAS\Gentry Mountain\Figures\GNTTRY\MTD.Jan1978toDec2006.xls

Figure 14

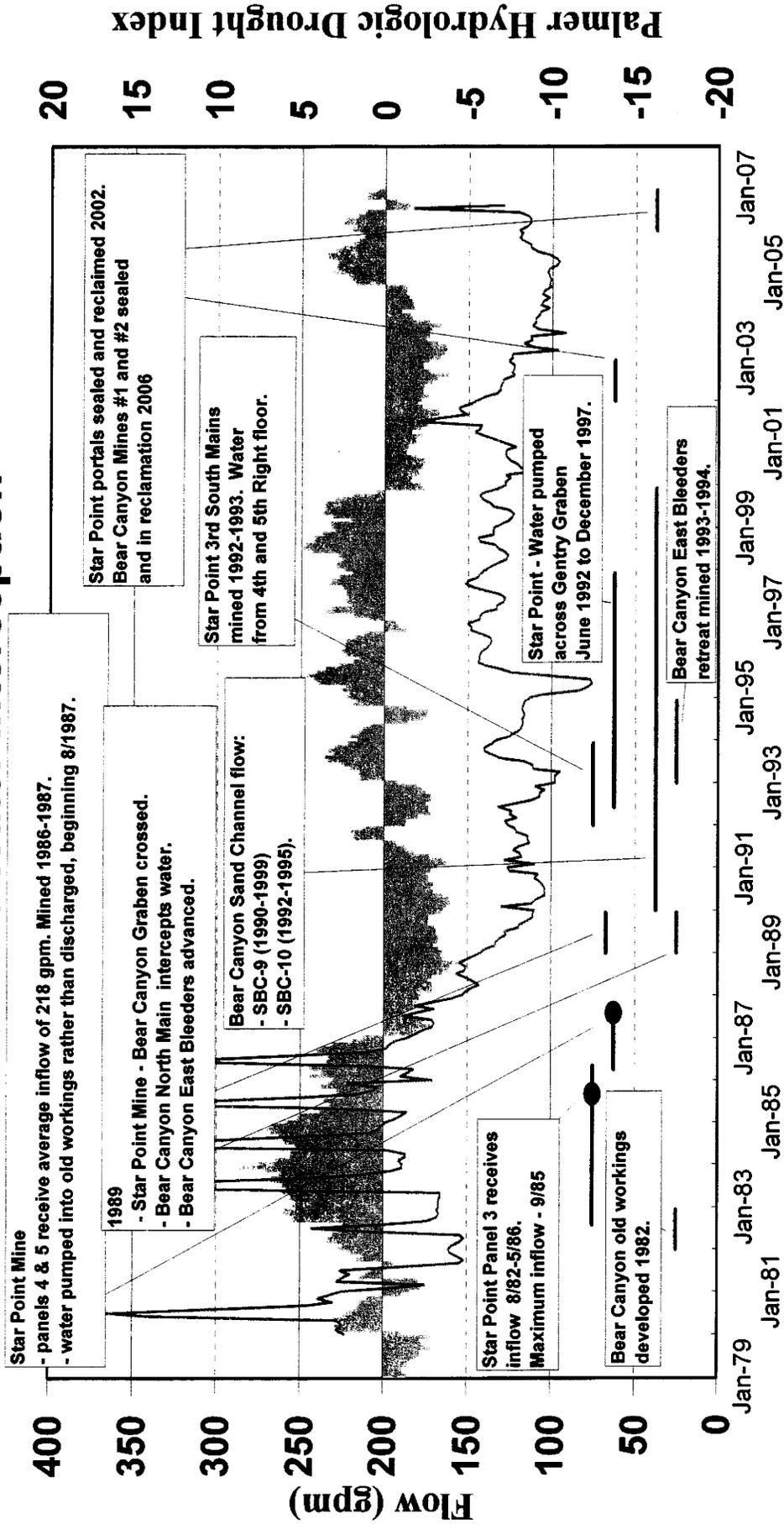
# Flow of Selected Springs and Region 5 PHDI



O:\CHIA\CHIAS\Gentry Mountain\Figures\GNTRYMTC.WB2:LBBBRegion5

Figure 14a

# Big Bear Spring, the PHDI, and Mine Water Interception

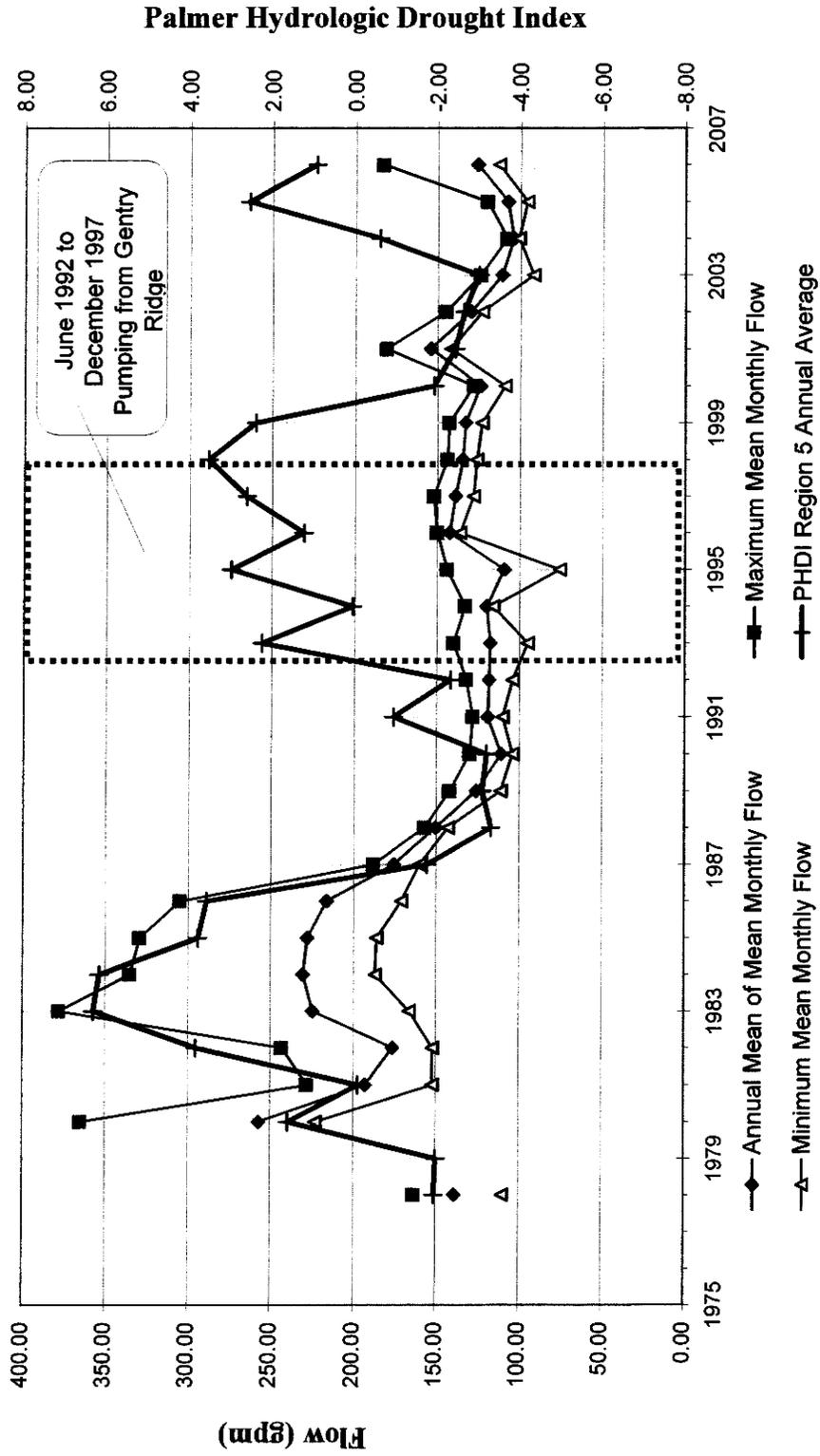


■ PHDI - Region 5 — Big Bear Spring

O:\CHIA\CHIAS\Gentry Mountain\Figures\GNTRYMTC.WB2:bigbrmimg 29JAN2007

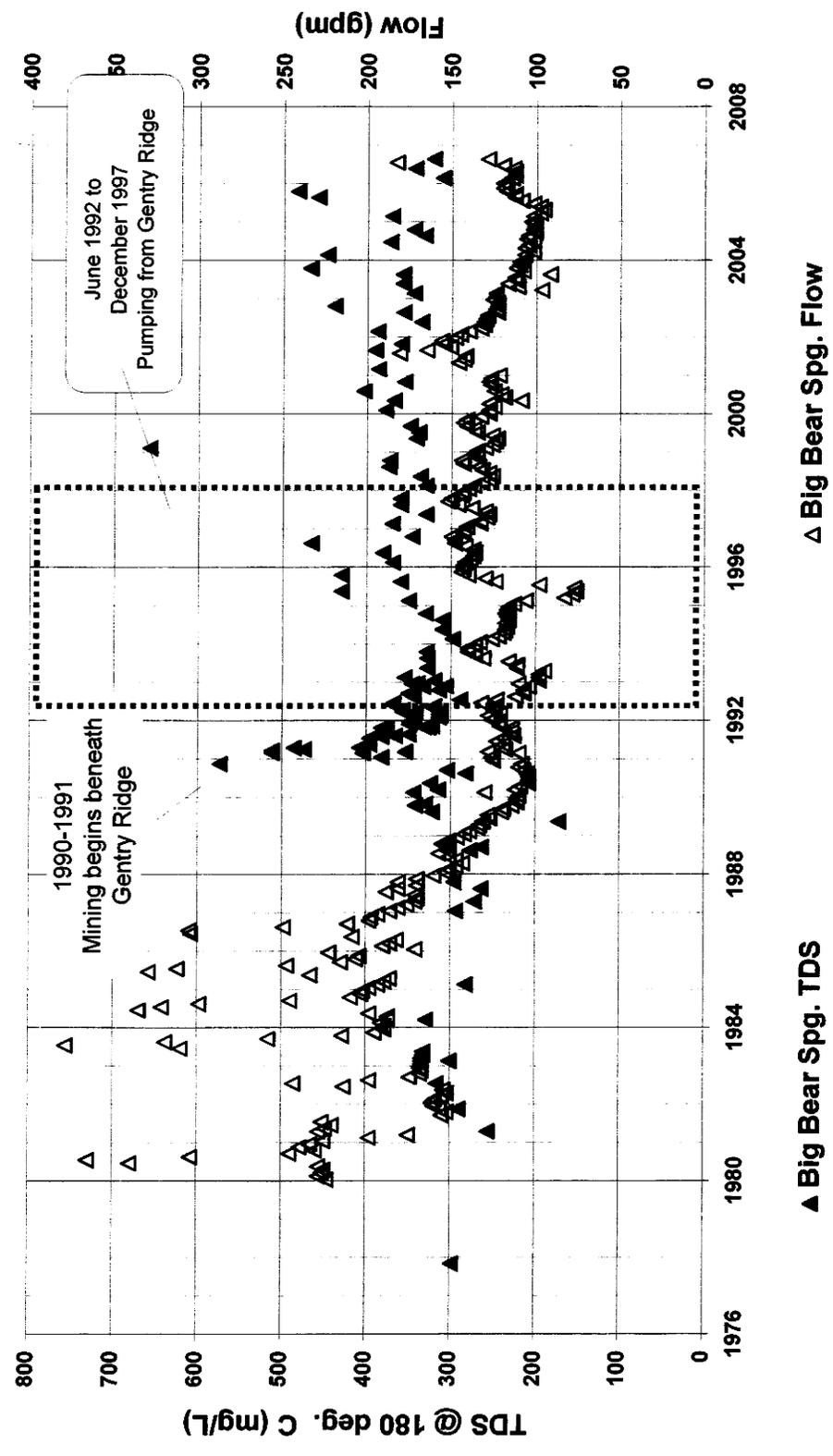
Figure 14b

# Big Bear Spring Annual Flows - NEWUSSD



**Figure 15**

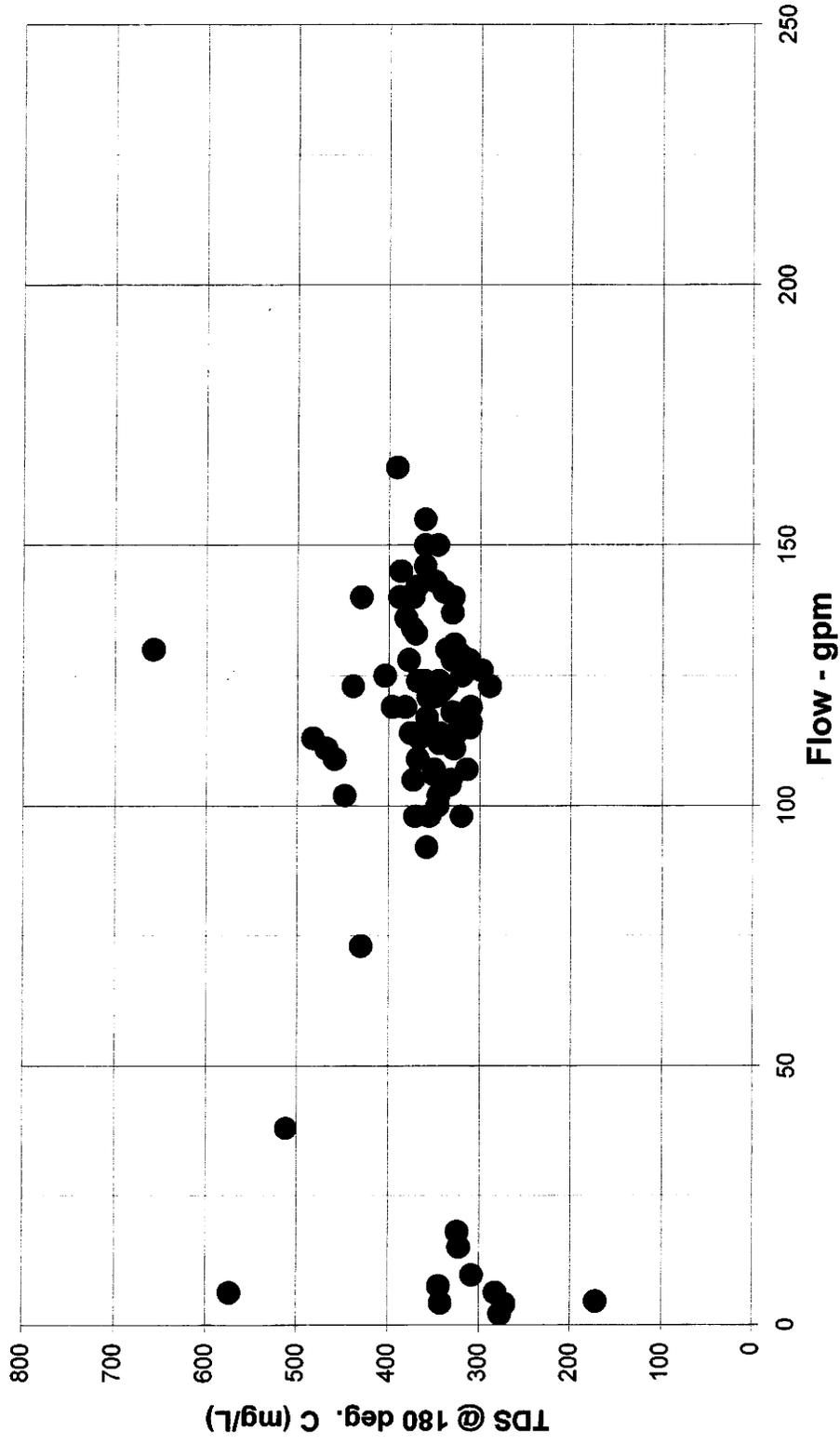
# Bear Canyon Mine: Big Bear Spring TDS vs Time



C:\CHIA\CHIAS\Gentry\Mountain\Final\GNTRY\MTD,Jan1976toDec2006.xls Figure 16a

Figure 16a

# Bear Canyon Mine: Big Bear Spring TDS vs Flow



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Figure 16b

# Meteoric Water Line Deuterium and Oxygen 18

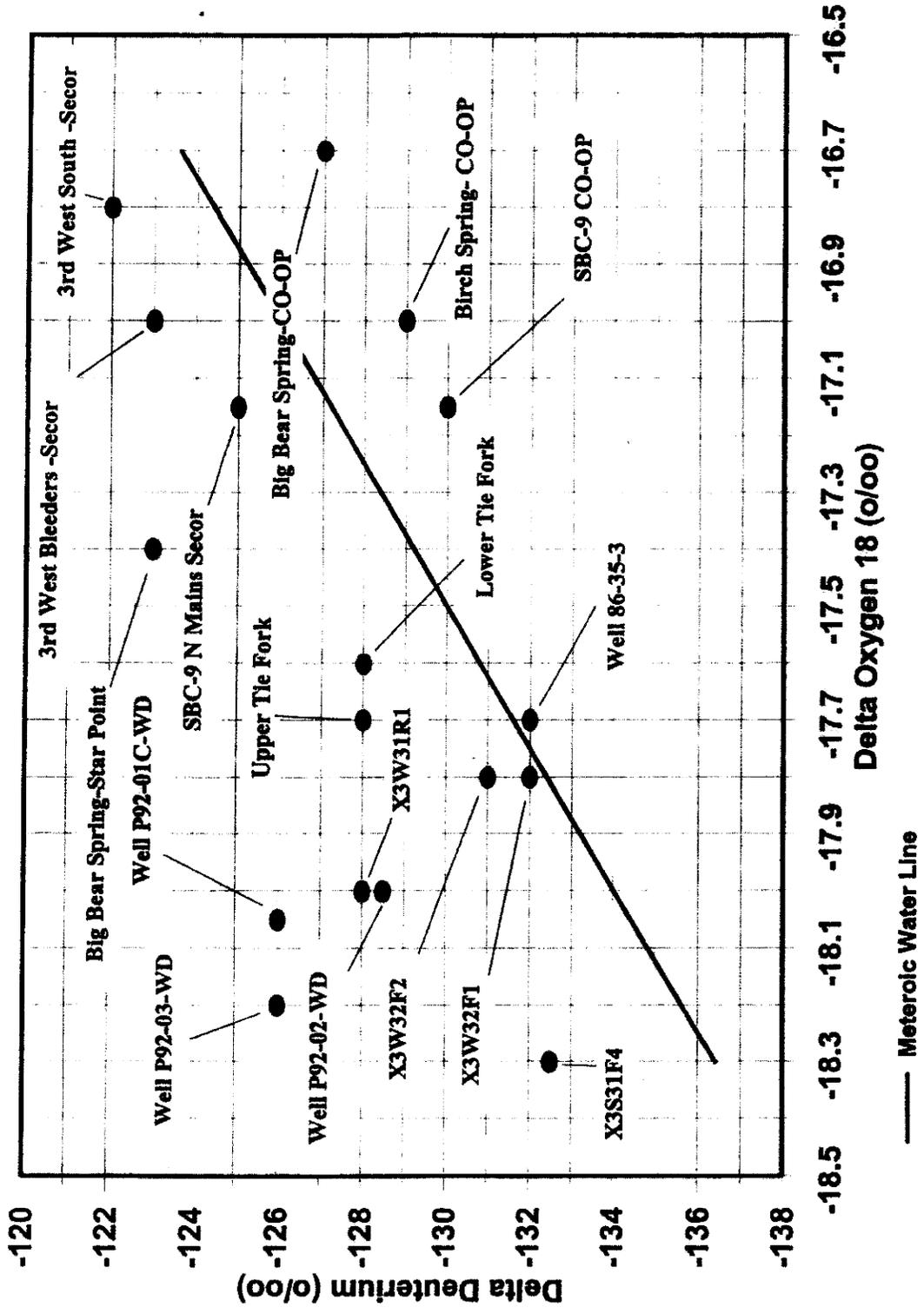
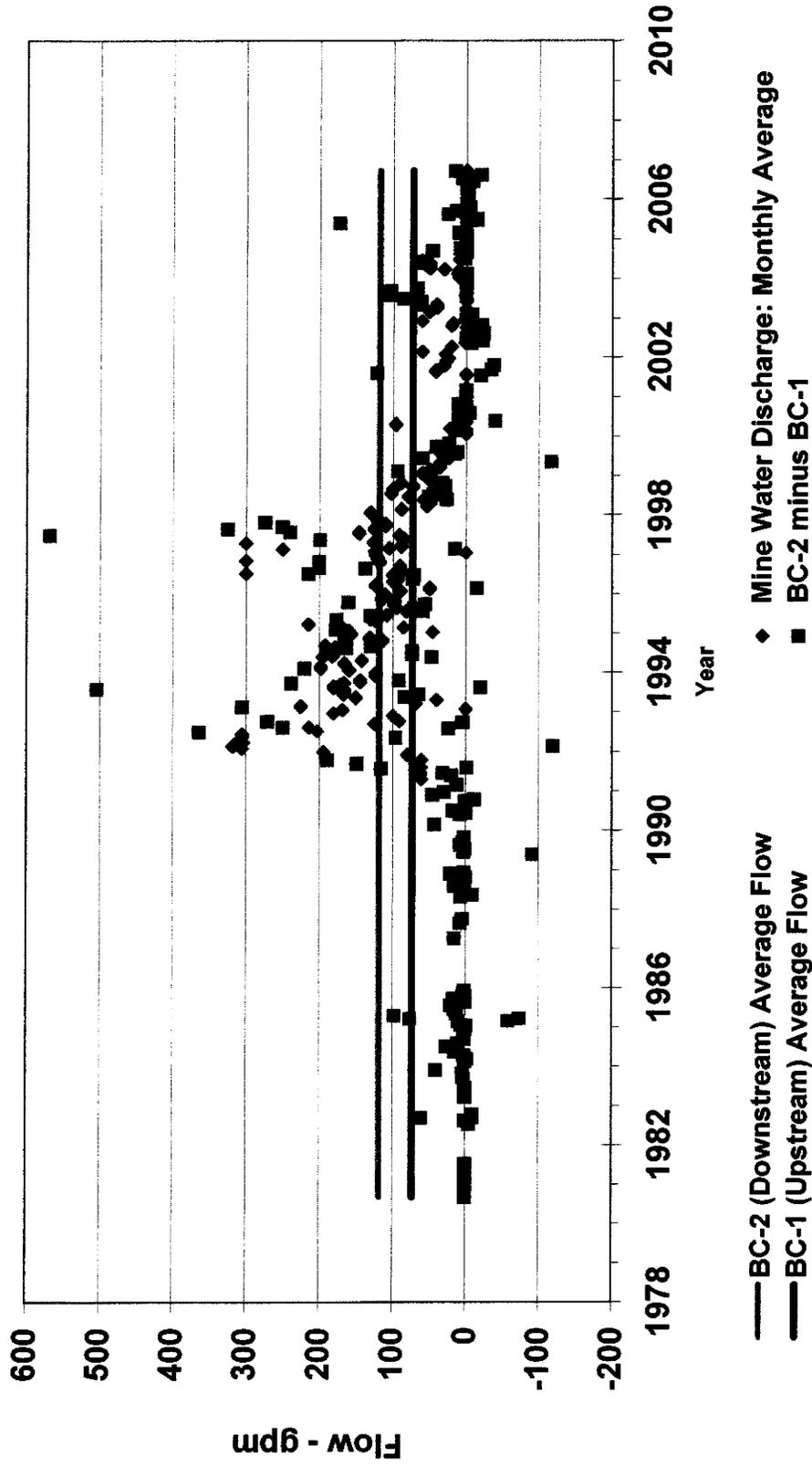


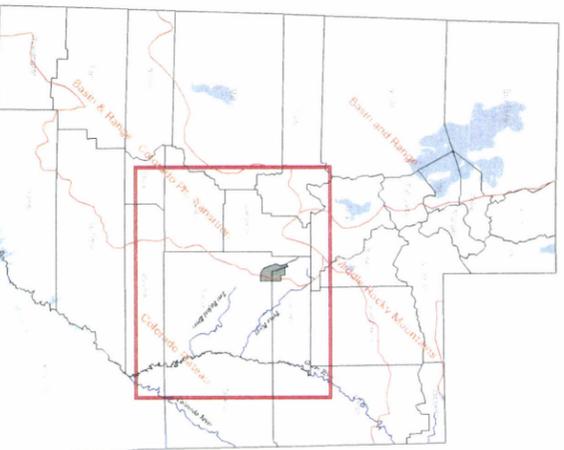
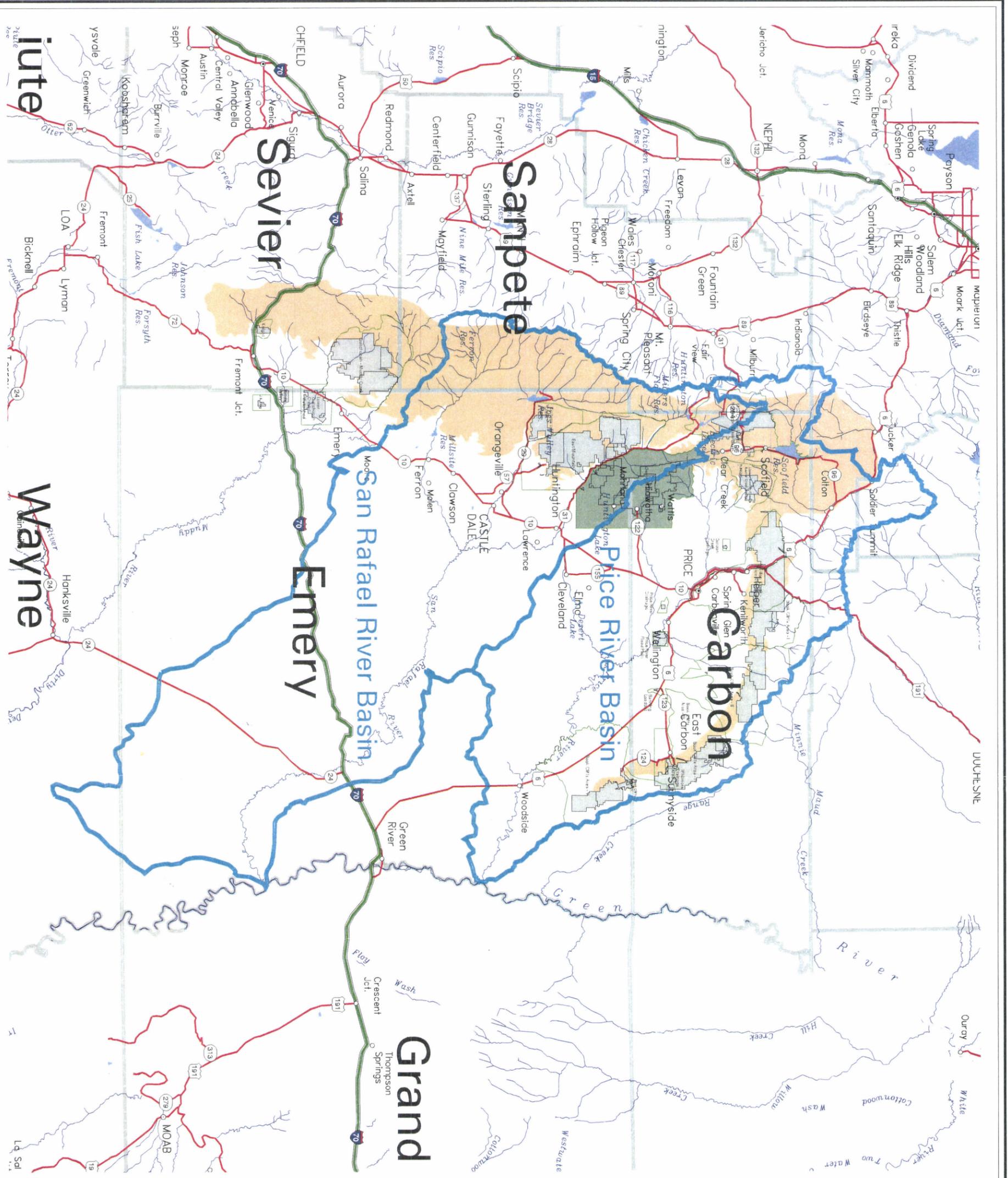
Figure 17

# Bear Canyon Mine Discharge & Bear Creek Flows

## Flow vs Time



**Figure 18**



Map 1  
 Cumulative Hydrologic Impact Assessment  
 Gentry Mountain

**LOCATION MAP**

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 Compiled by: Dan Smith Date: April 02, 2007

# Utah Coal Permit Areas and Palmer Hydrologic Index Climatic Divisions

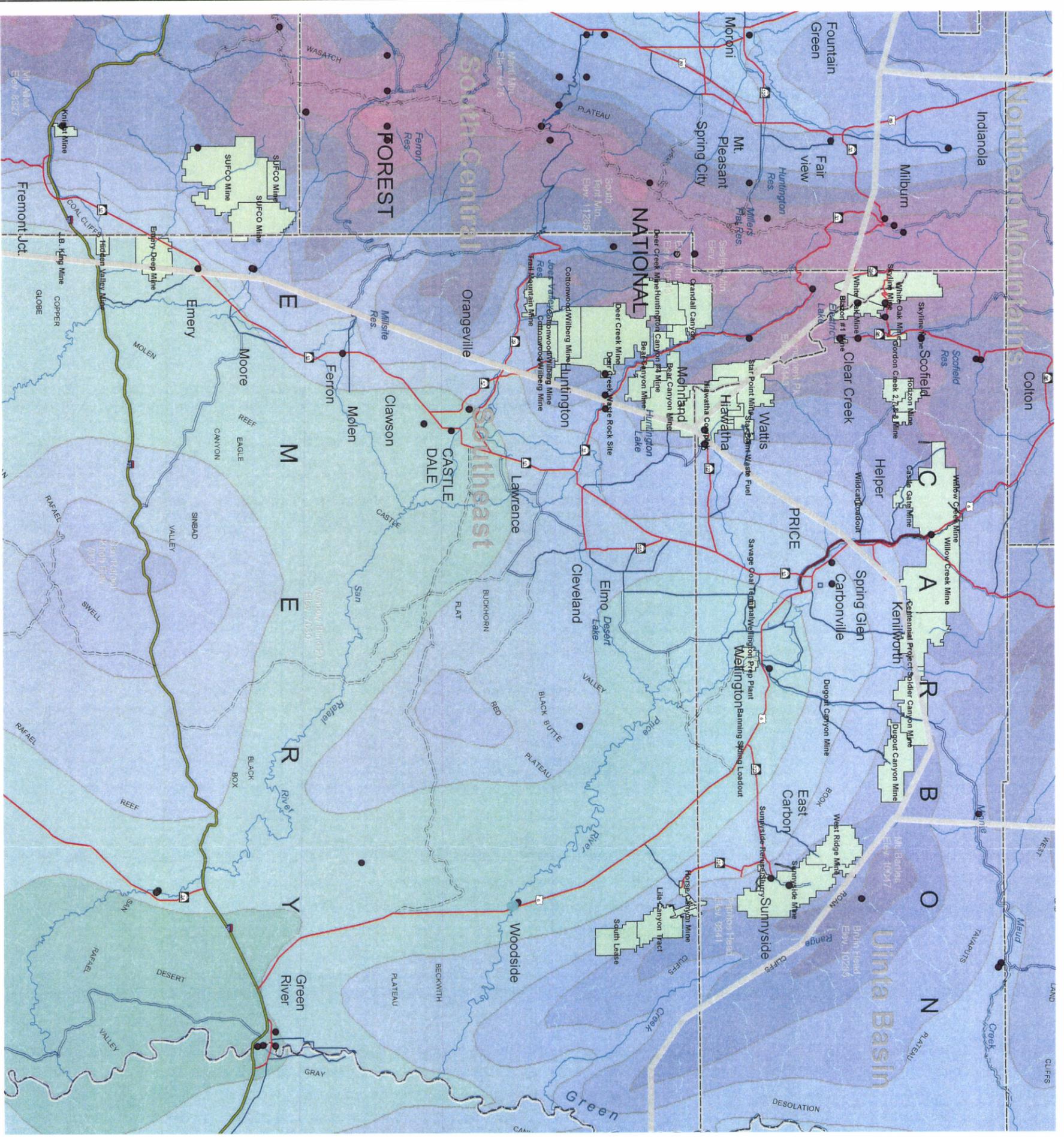


**Legend**

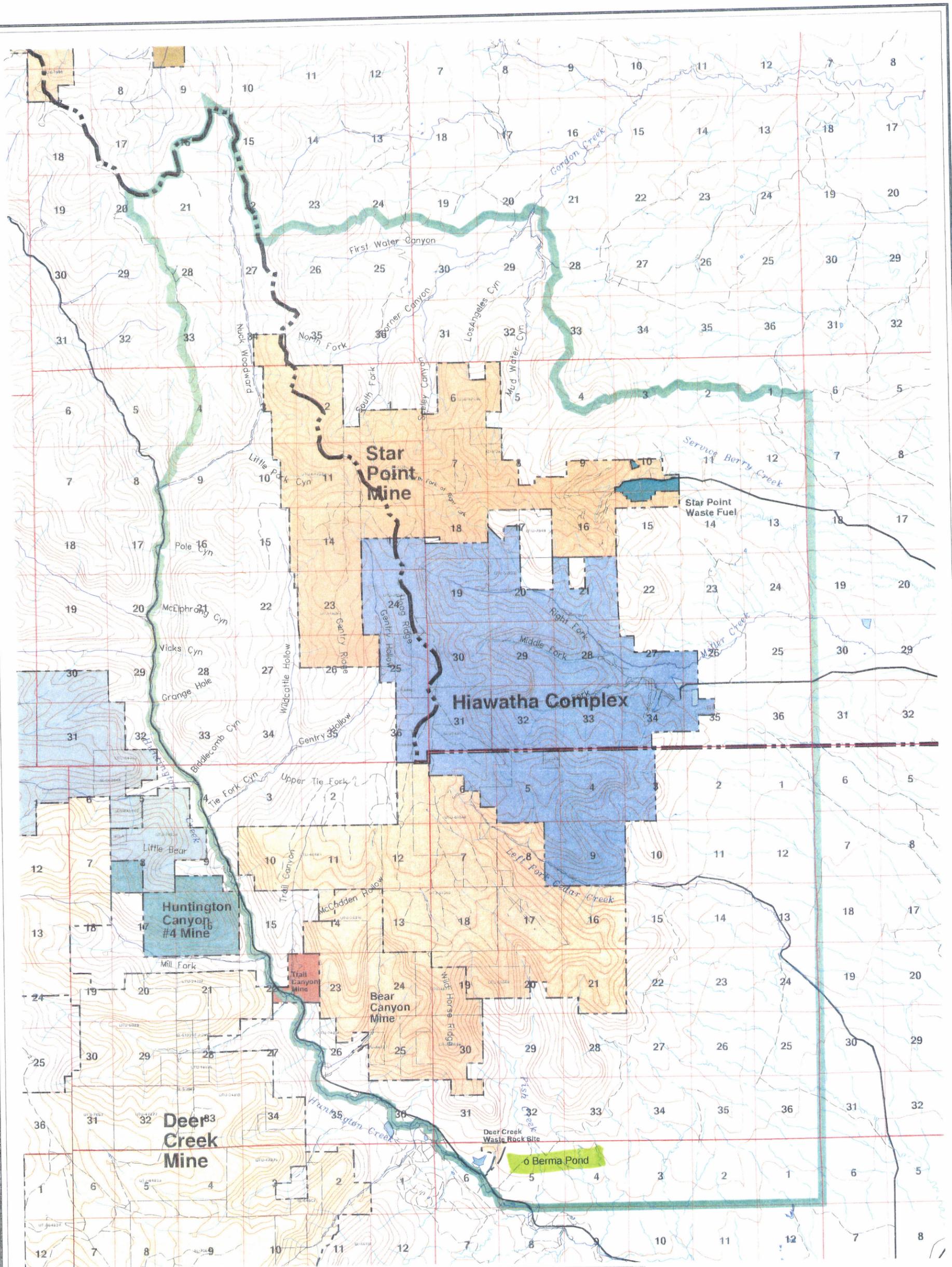
- Cooperative Weather Stations
- Roads**
  - Interstate
  - Divided Highway
  - Principle Highway
  - Improved Highway
  - Paved Local Roads
  - Improved Local Roads
  - Unimproved Local Roads
  - Climate Divisions
- County Boundaries**
  - 1
  - 2
- Coal Permit Areas

**Avg Normal Precip.**

- <6 inches
- 6-8 inches
- 8-10 inches
- 10-12 inches
- 12-16 inches
- 16-20 inches
- 20-25 inches
- 25-30 inches
- 30-40 inches
- 40-50 inches
- 50-60 inches
- >60 inches



The Cooperative Weather station data and Zones data was downloaded from the National Climatic Data Center web site.  
Coal Permit Area data produced by Division of Oil, Gas, and Mining.  
All other data obtained from Utah Automated Geographic Reference Center.  
Map produced Nov. 2006 by Daniel Smith



- CIA Area
- Intermittent Stream
- Perennial Stream
- Lease Boundary
- Contours 200ft Interval
- Main Road
- Graded Dirt Road
- Dirt Road
- County Boundary
- Permit Boundary

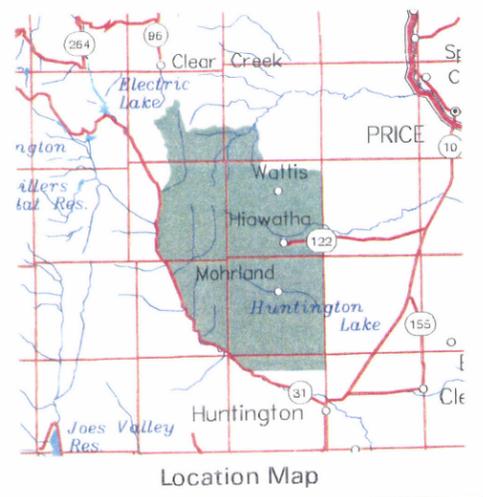
Map 2  
Cumulative Hydrologic Impact Assessment  
Gentry Mountain

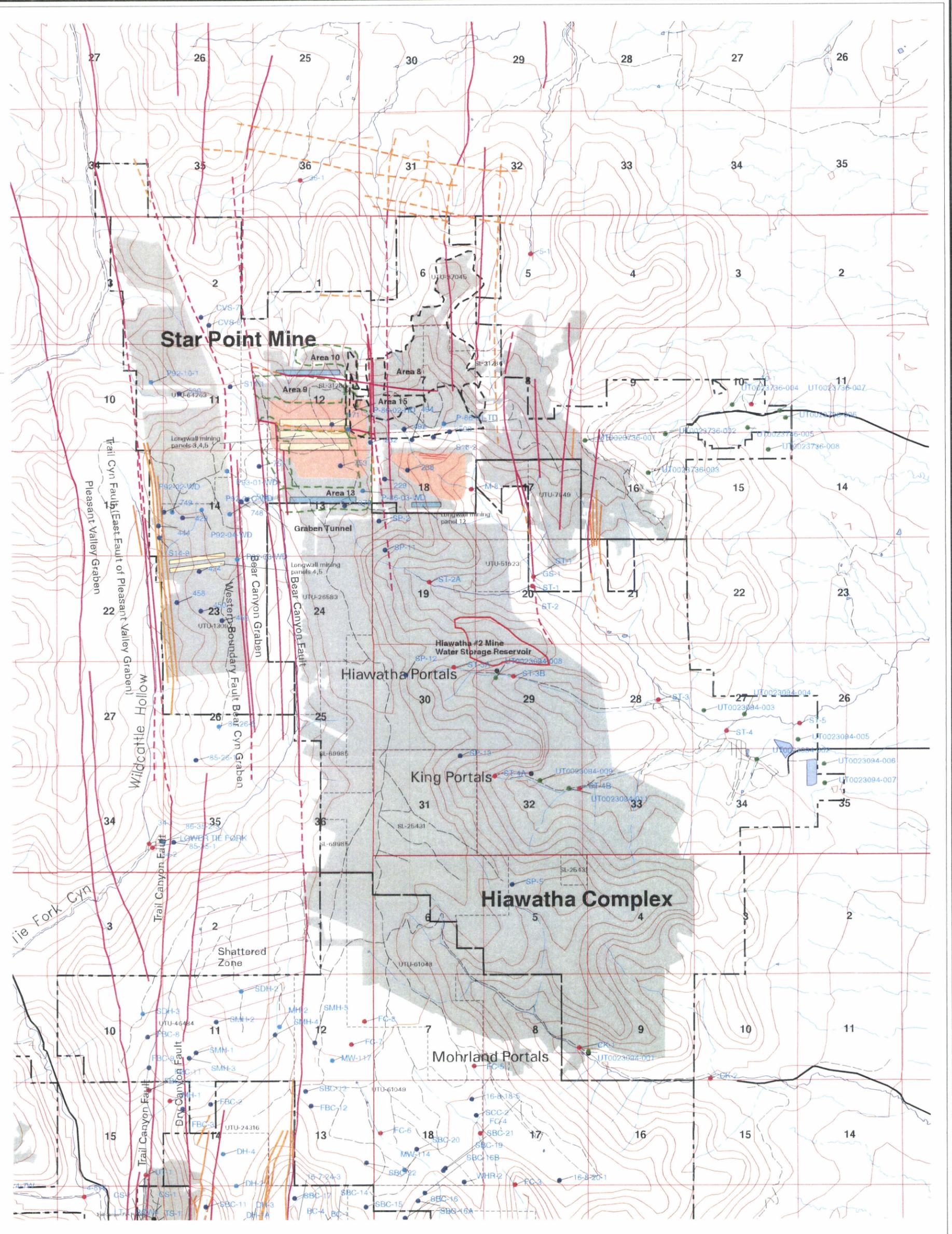
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**CUMULATIVE IMPACT AREA (CIA)**

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Compiled by: Dan Smith    Nov 2012





- Subsidence or break out areas
- Mined Areas
- Selected Long Wall Mining Panels
- Mined Mains
- Permit Area
- Watts Seam Sump Drainage Area
- Third Seam Sump Drainage Area
- Streams
- Major Faults
- Inferred Major Faults
- Minor Faults
- Inferred Minor Faults
- Subsidence Fractures
- Springs
- Wells
- Surface Water Monit. Site
- UPDES Monit. Site

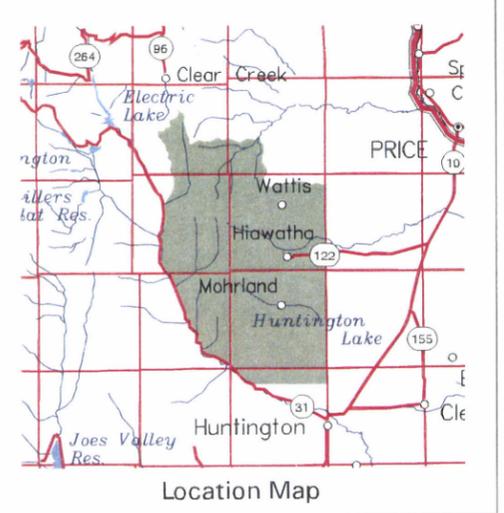
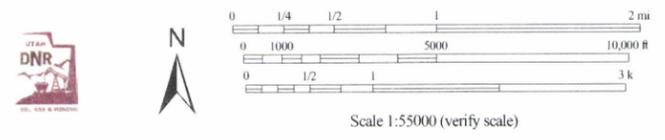
**Map 3**  
**Cumulative Hydrologic Impact Assessment**  
**Gentry Mountain**

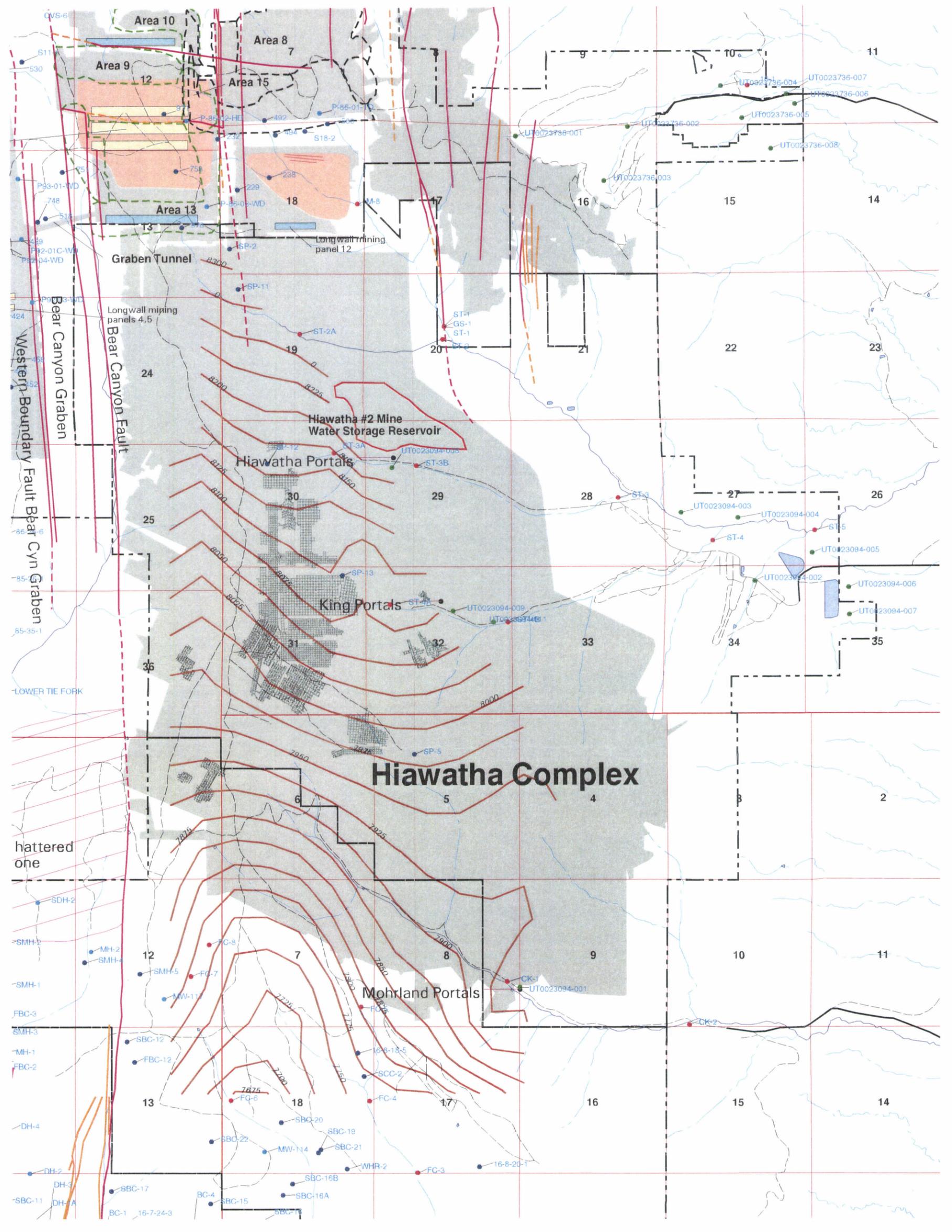
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**Star Point & Hiawatha**  
**Mining and Subsidence Areas**

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Compiled by: Dan Smith    Date: April 02, 2007





- Subsidence or break out areas
- Selected Long Wall Mining Panels
- Mined Mains
- Permit Area
- Watts Seam Sump Drainage Area
- Third Seam Sump Drainage Area
- Streams
- Major Faults
- Inferred Major Faults
- Minor Faults
- Inferred Minor Faults
- Subsidence Fractures
- Bottom of Coal Seam Contour
- Springs
- Wells
- Surface Water Monit. Site
- UPDES Monit. Site

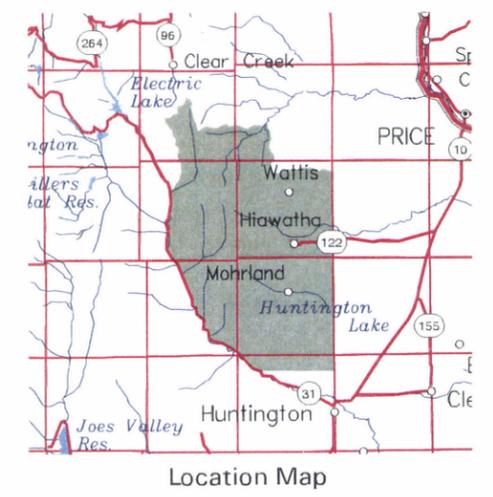
**Map 3a**  
**Cumulative Hydrologic Impact Assessment**  
**Gentry Mountain**

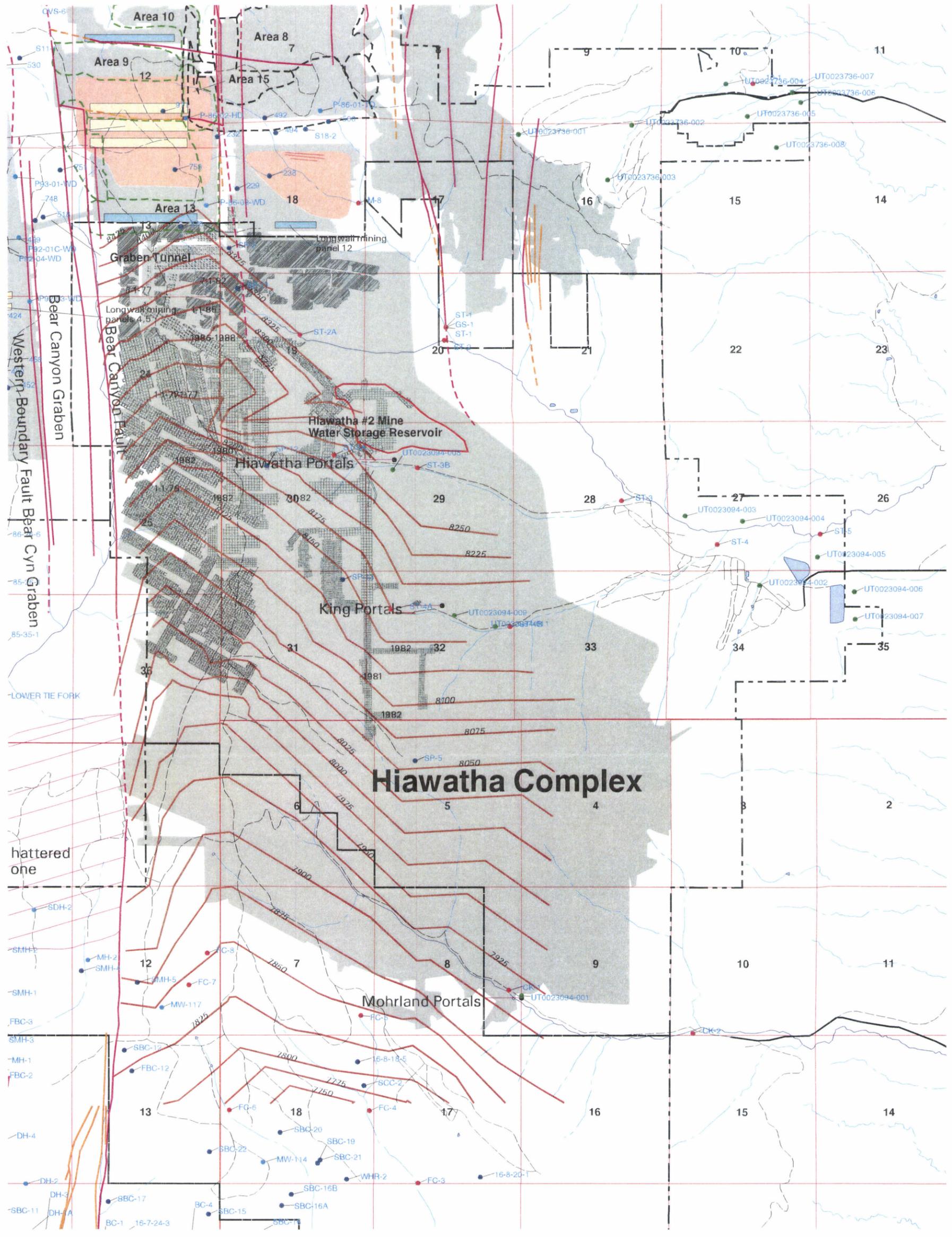
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**Hiawatha Mine - A Seam**  
**Mining and Subsidence Areas**

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Compiled by: Dan Smith    Date: April 02, 2007





- Subsidence or break out areas
- Selected Long Wall Mining Panels
- Mined Mains
- Permit Area
- Watts Seam Sump Drainage Area
- Third Seam Sump Drainage Area
- Streams
- Major Faults
- Inferred Major Faults
- Minor Faults
- Inferred Minor Faults
- Subsidence Fractures
- Bottom of Coal Seam Contour
- Springs
- Wells
- Surface Water Monit. Site
- UPDES Monit. Site

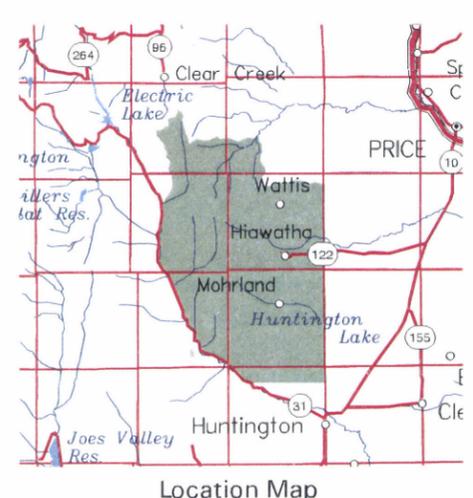
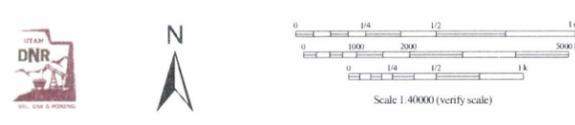
**Map 3b**  
**Cumulative Hydrologic Impact Assessment**  
**Gentry Mountain**

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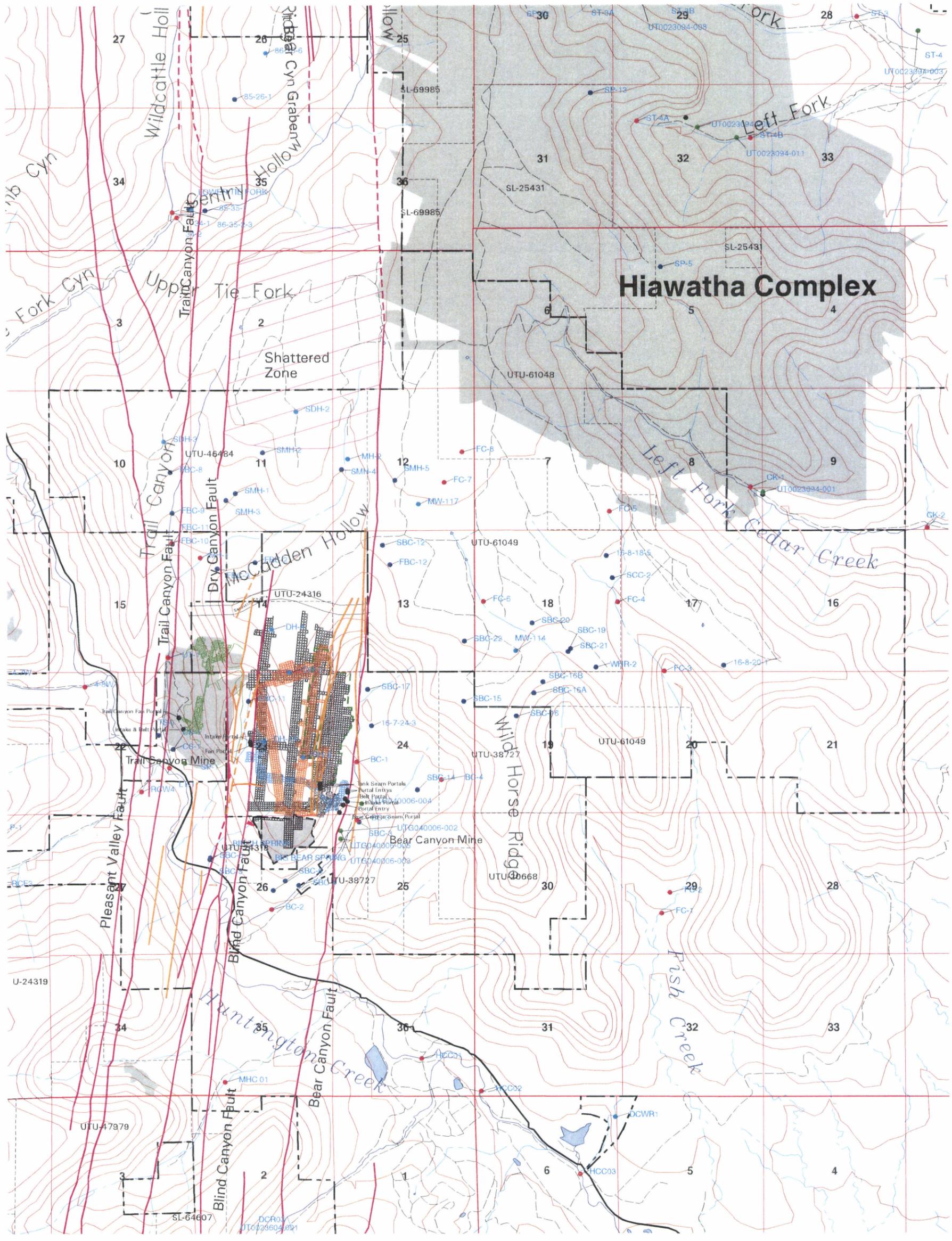
**Hiawatha Mine - B Seam**  
**Mining and Subsidence Areas**

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Compiled by: Dan Smith    Date: April 02, 2007







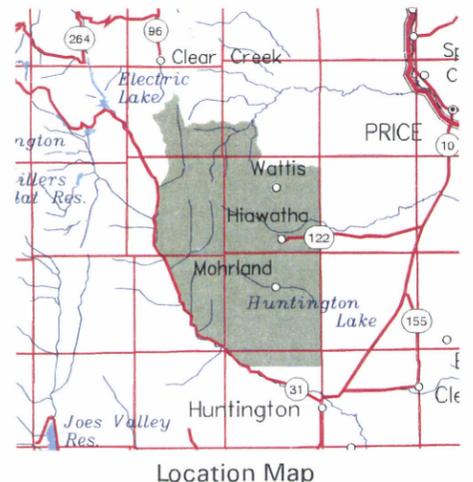
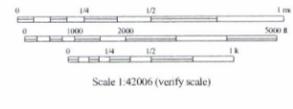
- Subsidence or break out areas
- Mined Areas
- Permit Area
- Blind Canyon Seam
- Hiawatha Seam
- Tank Seam
- Trail Canyon
- Streams
- Major Faults
- Inferred Major Faults
- Minor Faults
- Inferred Minor Faults
- Floor Seeps
- Springs
- Wells
- Surface Water Monit. Site
- UPDES Monit. Site

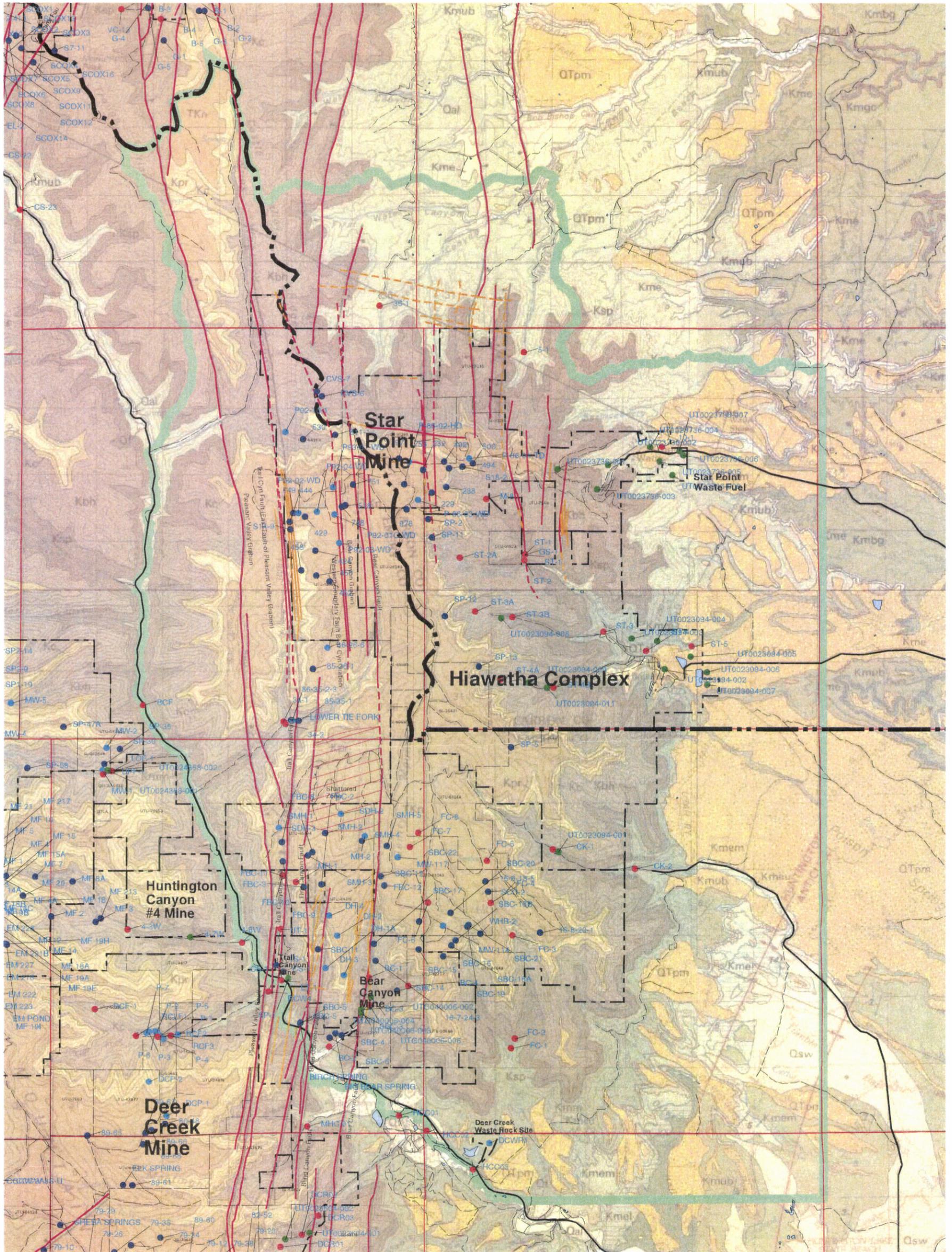
**Map 4**  
**Cumulative Hydrologic Impact Assessment**  
**Gentry Mountain**

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**Trail Canyon & Bear Canyon**  
**Mining and Subsidence Areas**

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 Compiled by: Dan Smith    Date: April 02, 2007





- CIA Area
- Permit Boundary
- Lease Boundary
- County Boundary
- Contours 200ft Interval
- Main Road
- Graded Dirt Road
- Dirt Road
- Springs
- Wells
- Surface Water Monit. Site
- UPDES Monit. Site

- TKfn - North Horn Fm
- Kpr - Price River Fm
- Kc - Castlegate Sandstone
- Kbh - Blackhawk Fm
- Ksp - Star Point Fm
- Km - Mancos Fm

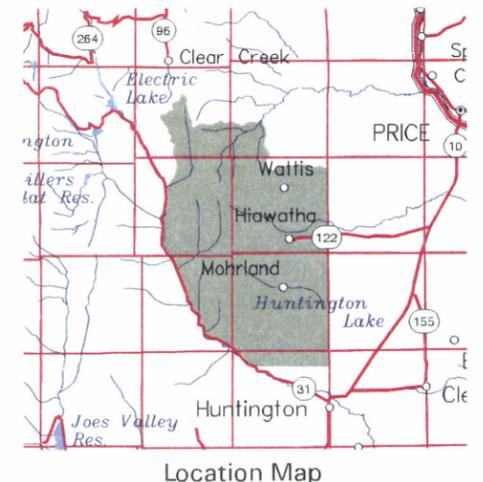
Map 5  
Cumulative Hydrologic Impact Assessment  
Gentry Mountain Mine

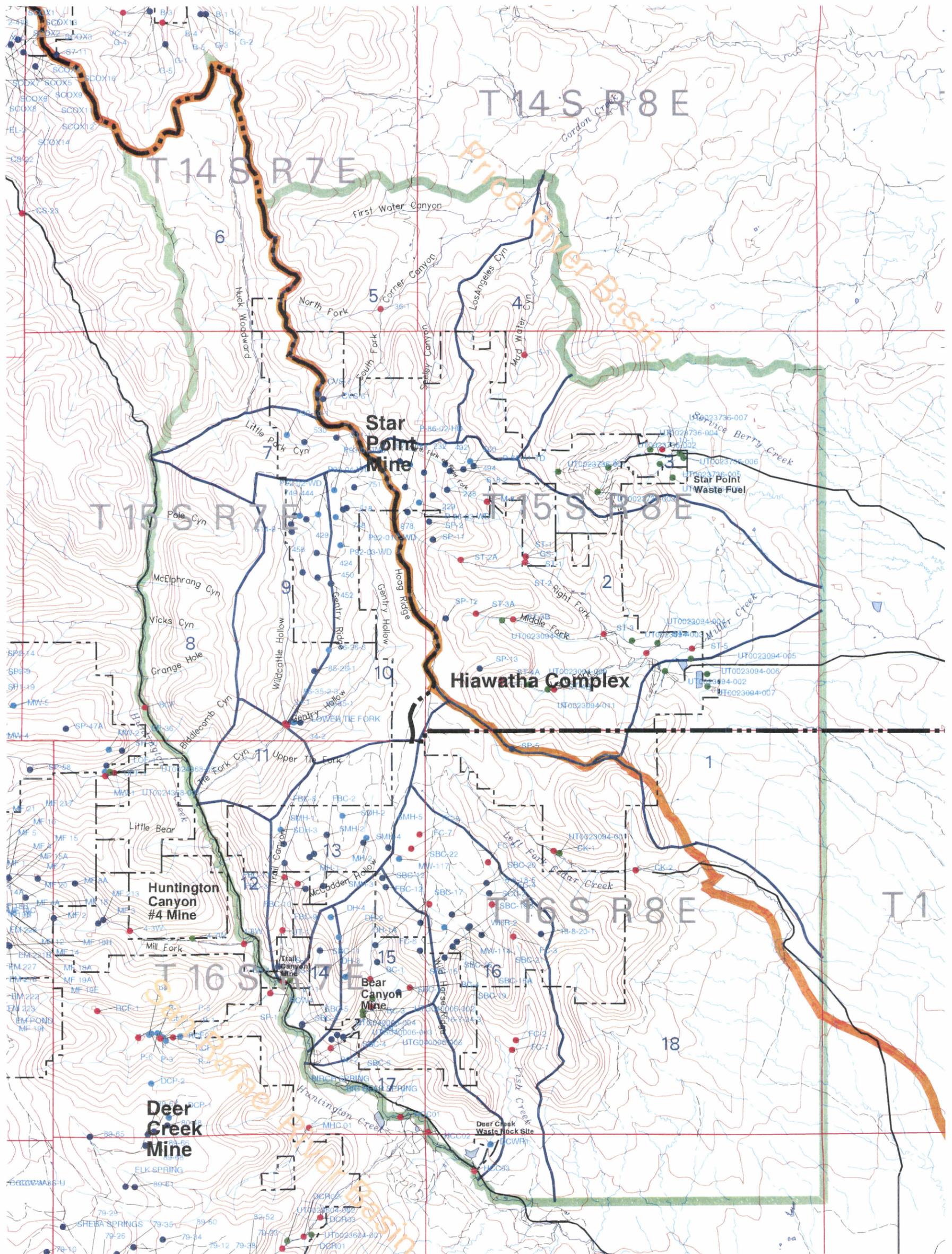
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**GENRTY MOUNTAIN GEOLOGY**

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Compiled by: Dan Smith    Date: April 02, 2007





- CIA Area
- Permit Boundary
- Intermittent Stream
- Perennial Stream
- Contours 200ft Interval
- Main Road
- Graded Dirt Road
- Dirt Road
- Major River Basin
- Springs
- Wells
- Surface Water Monit. Site
- Hydrograph Monit. Site
- 1 Sand Wash
- 2 Miller Creek
- 3 Serviceberry Creek
- 4 Mud Water Canyon
- 5 Corner Canyon
- 6 Nuck Woodward Creek North
- 7 Nuck Woodward Creek South
- 8 Huntington Creek Sub-basin
- 9 Wild Cattle Hollow
- 10 Gentry Hollow
- 11 Tie Fork Canyon
- 12 Huntington Creek Sub-basin
- 13 Trail Canyon
- 14 Birch Springs
- 15 Bear Canyon
- 16 Fish Creek
- 17 Huntington Creek Sub-basin
- 18 Cedar Creek

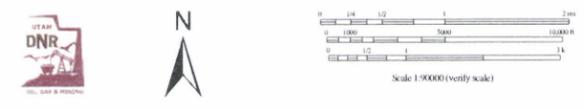
Map 6  
Cumulative Hydrologic Impact Assessment  
Gentry Mountain Mine

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**SURFACE HYDROLOGY**

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Compiled by: Dan Smith    Date: April 02, 2007





State of Utah

GARY R. HERBERT  
Governor

GREG BELL  
Lieutenant Governor

Office of the Governor  
PUBLIC LANDS POLICY COORDINATION OFFICE

KATHLEEN CLARKE  
Director

C/O 15/032 Incoming DRHV  
CC: Steve C,

#3997  
K

March 29, 2012

Dana Dean  
Associate Director\_Mining  
Department of Natural Resources, Division of Oil Gas and Mining  
1594 West North Temple, Suite 1210  
P.O. Box 145801  
Salt Lake City, UT 84114-5801

Subject: Construction of an Evaporation Basin for Crandall Canyon Mine, Emery County  
RDCC Project No. 31021

Dear Ms. Dean:

The State of Utah, through the Public Lands Policy Coordination Office (PLPCO), has reviewed this project. Utah Code (Section 63J-4-601, et. seq.) designates PLPCO as the entity responsible to coordinate the review of technical and policy actions that may affect the physical resources of the state, and to facilitate the exchange of information on those actions among federal, state, and local government agencies. As part of this process, PLPCO makes use of the Resource Development Coordinating Committee (RDCC). The RDCC includes representatives from the state agencies that are generally involved or impacted by public lands management.

**Department of Environmental Quality  
Division of Drinking Water**

There are no known drinking water sources in the immediate vicinity of this proposed project. However, to protect ground water quality, it is recommended that any such evaporation ponds be lined to prevent discharges into the subsurface.

The State of Utah appreciates the opportunity to review this proposal and we look forward to working with you on future projects. Please direct any other written questions regarding this correspondence to the Public Lands Policy Coordination Office at the address below, or call Judy Edwards at (801) 537-9023.

Sincerely,

Kathleen Clarke  
Director



GARY R. HERBERT  
*Governor*

GREGORY S. BELL  
*Lieutenant Governor*

## State of Utah

DEPARTMENT OF NATURAL RESOURCES

MICHAEL R. STYLER  
*Executive Director*

Division of Oil, Gas and Mining

JOHN R. BAZA  
*Division Director*

Internal  
C0150032  
#4163  
OK

November 2, 2012

To: Internal File

From: Daron R. Haddock, Coal Program Manager 

Subject: 510 (c) Recommendation for Genwal Resources, Inc., LLC, Crandall Canyon Mine, C/015/0032, Task ID #4163

As of writing of this memo, there are no NOV's or COs which are not corrected or in the process of being corrected for the Crandall Canyon Mine. There are no finalized civil penalties, which are outstanding and overdue in the name of Genwal Resources, Inc. Genwal Resources, Inc. does not have a demonstrated pattern of willful violations, nor have they been subject to any bond forfeitures for any operation in the state of Utah.

Attached is a recommendation from the OSM Applicant Violator System for the Crandall Canyon Mine that states there are no outstanding violations.

O:\015032.CRA\PERMIT\2012Revised\AVSMemo.doc





suzanne.steab (UT) |

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**Evaluation on Application Number: ACT015032 SEQ:5  
0 Violations**

[Print Report](#)

**Application Evaluation**

Application Number	ACT015032 SEQ:5
Applicant Name	136398 Genwal Resources Inc
Date of Request	11/2/2012 11:19:43 AM
Requestor	suzanne.steab

**CAUTION: The Applicant/Violator System (AVS) is an informational database. Permit eligibility determinations are made by the regulatory authority with jurisdiction over the permit application not by the AVS. Results which display outstanding violations may not include critical information about settlements or other conditions that affect permit eligibility. Consult the AVS Office at 800-643-9748 for verification of information prior to making decisions on these results.**

There were no violations retrieved by the system

**Evaluation OFT**

Entities: 23

- 249974 Fifth Third Bank of NE Ohio Trustee (Murray 2003 Trust) - ()
- 159562 Murray Energy Holdings Co - (Subsidiary Company)
- 107933 Michael O Mckown - (Director)
- 107933 Michael O Mckown - (Secretary)
- 108943 Robert Eugene Murray - (Chief Executive Officer)
- 108943 Robert Eugene Murray - (Director)
- 108943 Robert Eugene Murray - (President)
- 112675 Michael D Loiacono - (Treasurer)
- 151206 Robert D Moore - (Chief Financial Officer)
- 151206 Robert D Moore - (Director)

-----152552 Murray Energy Corp - (Subsidiary Company)  
-----107933 Michael O Mckown - (Secretary)  
-----107933 Michael O Mckown - (Senior Vice President)  
-----108943 Robert Eugene Murray - (Chairman of the Board)  
-----108943 Robert Eugene Murray - (Chief Executive Officer)  
-----108943 Robert Eugene Murray - (Director)  
-----108943 Robert Eugene Murray - (President)  
-----112675 Michael D Loiacono - (Treasurer)  
-----132376 Henry W Fayne - (Director)  
-----138824 G Christopher Van Bever - (Assistant Secretary )  
-----144388 B J Cornelius - (Senior Vice President)  
-----146487 Utahamerican Energy Inc - (Subsidiary Company)  
-----107933 Michael O Mckown - (Secretary)  
-----108943 Robert Eugene Murray - (Director)  
-----112234 Andalex Resources Inc - (Subsidiary Company)  
-----107933 Michael O Mckown - (Secretary)  
-----108943 Robert Eugene Murray - (Director)  
-----136398 Genwal Resources Inc - (Subsidiary Company)  
-----107933 Michael O Mckown - (Secretary)  
-----108943 Robert Eugene Murray - (Director)  
-----151206 Robert D Moore - (Treasurer)  
-----153542 David W Hibbs - (Director)  
-----153542 David W Hibbs - (President)  
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-----151206 Robert D Moore - (Treasurer)  
-----153542 David W Hibbs - (Director)  
-----153542 David W Hibbs - (President)  
-----149224 John R Forrelli - (Senior Vice President)  
-----151206 Robert D Moore - (Chief Operations Officer)  
-----151206 Robert D Moore - (Director)  
-----156388 James R Turner Jr - (Senior Vice President)  
-----156726 Richard L Lawson - (Director)  
-----157762 Roy A Heidelberg - (Vice President)  
-----159563 Robert Edward Murray - (Vice President)  
-----159564 Ryan Michael Murray - (Vice President)  
-----253490 Michael T W Carey - (Vice President)  
-----159563 Robert Edward Murray - (Shareholder)  
-----159564 Ryan Michael Murray - (Shareholder)  
-----159565 Jonathan Robert Murray - (Shareholder)  
250292 Murray, Robert Eugene Trustee, (REM Family Trust) - ()  
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**Narrative**

Request Narrative