#5918

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

Sufco Mine
John D. Byars
General Manager
597 South SR24
Salina, Utah 84654
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APR 01 2019
DIV OF OIL, GAS & MINING

March 27, 2019

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

Re: First Mining of the Pines East Panels, Task ID#5852, Canyon Fuel Company, LLC, Sufco Mine, C/041/002

Dear Sirs:

Please find enclosed with this letter an amendment to address the "first-mining" of coal panels in the eastern region of the Pines Lease Tract (UTU-76195). The proposed underground mining is first-mining only, no subsidence is projected in association with the mining.

The M&RP contains text, appendices, tables and drawings previously submitted and approved for the lease. Some of the currently approved information pertaining to the lease and the proposed mining has been highlighted and included for ease of review.

Locations of Pines East Panels Information:
Chapter 1 - Legal & Financial- Legal Description Lease UTU-76195
Chapter 2 – Soils- Pines Tract Soil Types Plate 2-2 and Appendix 2-1, 2-8
Chapter 3 – Biology- Vegetation and Wildlife Pines Tract – Appendix 3-9, Plates 3-1, 3-2, 3-3
Raptors in Appendix 3-4 and Plate 3-3
Mexican Spotted Owls – Appendix 3-12
Bat Survey – Appendix 3-8
Chapter 4 - Land Use & Historical-Appendix 4-2, 4-5, 4-6, Plate 4-1
Chapter 5 - Engineering – Plates 5-1, 5-2D, 5-2E, 5-2F, 5-6, 5-7, 5-8, 5-10, 5-10C, 5-11
Chapter 6 - Geology – Plates 6-1, 6-2, 6-3, 6-4
Chapter 7 – Hydrology – Pines Tract Hydrology 7-18, Plates 7-2, 7-3, 7-10, Appendix 7-1, 7-4, 7-17, 7-18, 7-22
Appendix 7-1 Contains: Water Rights and Location Drawing (2018)
Appendix 7-4 Contains:
Baseline Hydrologic Monitoring at the Link Canyon Mine Portals (2002)
Hydrology and Effects of Mining in the Quitchupah and Pines Coal Lease Tracts, Central Utah (1991)
Appendix 7-18 Contains:
Investigation of Surface-Water and Groundwater Systems in the Pines Tract Area (1999)
Hydrologic Evaluation of Spring Pines 310 (2018)

Appendix 7-22 Contains:
Investigation Plan for Springs Pines 105, Joes Mill Pond, Pines 310 and 311 (2006)

Exploration drilling occurred during 2018, the raptor, wildlife and archeological reports associated with the drilling have been included in the submittal. They are to be included in Confidential Appendices 3-4 and 4-2.

Two water monitoring locations have been added at the request of Keenan Storrar. The locations appear on the water monitoring Plate 7-10 and the monitoring tables within Chapter 7 have been updated with the commitment for monitoring these locations.

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

CANYON FUEL COMPANY
SUFCO Mine

Vicky S Miller
for

Jacob Smith
Engineering Manager

Encl.

cc: DOGM Correspondence File

APPLICATION FOR COAL PERMIT PROCESSING

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

Permittee: Canyon Fuel Company, LLC
Mine: Sufco Mine **Permit Number:** C/041/002
Title: Revision to M&RP to Add Pines East Panels, Task ID # 5852
Description, Include reason for application and timing required to implement:
First Mining Only Application

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

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

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

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

Jacob Smith
Print Name

, Engineering Manager, 3/27/2019
Sign Name, Position, Date

Subscribed and sworn to before me this 27th day of March, 2019

Jill White
Notary Public

My commission Expires: 03/28, 2020

Attest: State of Utah } ss:
County of Sevier

JILL WHITE
Notary Public
State of Utah
My Commission Expires 03/28/2020
COMMISSION NUMBER 687959

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining
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APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

Permittee: Canyon Fuel Company, LLC
Mine: Sufco Mine **Permit Number:** C/041/002
Title: Revision to M&RP to Add Pines East Panels, Task ID# 5852

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

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☐ Replace	☐ Remove	M&RP Confidential
☒ Add	☐ Replace	☐ Remove	Appendix 3-4 - Add information to the back of the existing appendix
☒ Add	☐ Replace	☐ Remove	Appendix 4-2 - Add information to the back of the existing appendix
☐ Add	☒ Replace	☐ Remove	Plate 5-10C
☐ Add	☐ Replace	☐ Remove	
☐ Add	☒ Replace	☐ Remove	Chapter 2, Page 2-8
☐ Add	☒ Replace	☐ Remove	Chapter 3, Pages 3-11, 3-12, 3-17, 3-18, 3-29 thru 3-33
☐ Add	☒ Replace	☐ Remove	Plate 3-3
☐ Add	☒ Replace	☐ Remove	Chapter 4, Page 4-13
☐ Add	☒ Replace	☐ Remove	Chapter 5, Pages 5-11, 5-1 and 5-26
☐ Add	☒ Replace	☐ Remove	Plates 5-1, 5-7, 5-10, 5-11
☐ Add	☒ Replace	☐ Remove	Chapter 6, Page 6-4
☐ Add	☒ Replace	☐ Remove	Plate 6-1
☐ Add	☒ Replace	☐ Remove	Chapter 7, Pages 7-5, 7-7, 7-49, 7-50, 7-53, 7-55, 7-56, 7-62, 7-128
☒ Add	☐ Replace	☐ Remove	Appendix 7-1 - Add information to the back of the existing appendix
☒ Add	☐ Replace	☐ Remove	Appendix 7-4 - Add information to the back of the existing appendix
☒ Add	☐ Replace	☐ Remove	Appendix 7-18 - Add information to the back of the existing appendix
☐ Add	☒ Replace	☐ Remove	Plate 7-2, 7-3, 7-10
☐ Add	☐ Replace	☐ Remove	
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.

March 27, 2019

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CHAPTER 1

GENERAL CONTENTS

Federal Coal Lease UTU-76195 - (4,148.15 acres +/-) - Approved October 1999
Modified December 2006, January 2017

T. 21 S., R. 5 E., SLM

Sec. 2, lots 3,4, S1/2SW1/4, SW1/4SE1/4
Sec. 10, NE1/4NE1/4
Sec. 11, NE1/4, SE1/4, NW1/4NW1/4, NE1/4NW14,
SE1/4NW1/4, N1/2SW1/4NW1/4, SW1/4SW1/4NW1/4,
E1/2SW1/4, E1/2NW1/4SW1/4,SE1/4SW1/4NW1/4
Sec. 12, S1/2SW1/4, NW1/4SW1/4
Sec. 13, NW1/4, S1/2
Sec. 14, NE1/4, E1/2NW1/4, E1/2E1/2SE1/4
Sec. 22, S1/2S1/2SE1/4
Sec. 23, SE1/4, E1/2SW1/4, S1/2SW1/4SW1/4, S1/2SE1/4NW1/4,
SE1/4NW1/4NE1/4, S1/2NE1/4NE1/4, NE1/4NE1/4NE1/4,
S1/2SW1/4NE1/4, NE1/4SW1/4NE1/4, SE1/4NE1/4
Sec. 24, all
Sec. 25, N1/2, N1/2S1/2
Sec. 26, N1/2, NE1/4SW1/4, E1/2NW1/4SW1/4, SE1/4

T. 21 S., R. 6 E., SLM

Sec. 19, lots 3-4, E1/2SW1/4
Sec. 30, lots 1-3, E1/2NW1/4, NE1/4SW1/4

Federal Coal Lease UTU-84102 - (6,175.39 acres) - Effective April 1, 2017

T. 20 S., R. 4 E., SLM

Sec. 36, lot 4, E1/2NE1/4, NE1/4SE1/4

T. 20 S., R. 5 E., SLM

Sec. 19, lots 5-8, E1/2SW1/4, SE1/4
Sec. 20, S1/2
Sec. 21, W1/2SW1/4
Sec. 28, W1/2

CHAPTER 2

SOILS

LIST OF PLATES

Plate

2-1 Native Soil Types Present in SUFCO Mine Disturbed Area & Surrounding Area

2-2 Soil Types Pines Tract

2-3 Soil Types SITLA Muddy Tract

LIST OF APPENDICES

(Appendices appear in Volume 4)

Appendix

2-1 Prime Farmland Determination Documents

2-2 Report of Studies of Vegetation and Soils for SUFCO Mine

2-3 Water and Soil Data Report

2-4 Submittal of Drainage Plan and Slope Stability for Reclamation for Convulsion Canyon Mine, Sergent, Hauskins & Beckwith

2-5 Final Reclamation Cut and Fill Quantities

2-6 Link Canyon Substation Soils Investigation

2-7 Quitchupah Tract Supplemental Environmental Assessment 1989 and Environmental Assessment for Coastal States Energy Company, Coal Lease Application U-63214 Quitchupah Tract

2-8 Pines Tract Soils Types

2-9 Link Canyon Portal Vegetation, Aquatic Fauna, and Soil Investigations

2-10 Muddy Tract Soils Types

and limestone are also present. The landscape is steep and rocky with massive sandstone ledges, and siltstone/shale slopes. Surface and subsurface layers are often rocky.

2.2.1 Prime Farmland Investigation

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

2.2.2 Soil Survey

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

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

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

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

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

2.2.2.1 Soils Map

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

2.2.2.2 Soil Identification

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

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

2.2.2.3 Soil Description

Soil Type O

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

Overflow Pond Soils

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

Link Canyon Soils

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

Link Canyon Mine Portals

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

Pines Tract

The general description of the soils within the Pines Tract is provided in Appendix 2-8. No surface disturbance associated with the mining of the Pines East Panel(s) is planned on the Pines Tract Lease.

SITLA Muddy Tract and Greens Hollow Tract

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

3 Right 4 East - Quitchupah Tract

A general description of the soils associated with the Quitchupah Tract is provided in the Supplemental Environmental Assessment prepared by UDOGM October 27, 1989, included in Appendix 2-7. No surface disturbance as in the construction of facilities, etc. is associated with the ming of the 3 Right 4 East panel(s)

CHAPTER 3

BIOLOGY

4 Right 4 East Panel - Elk & Mule Deer

The 4R4E panel is located in the southern portion of the Quitchupah Lease (See Plated 5-6 and 5-7 of the M&RP). The panel is located just outside of within what is considered crucial or critical winter range for deer and elk. The escarpment in the southeastern portion of the tract which lies between Quitchupah Canyon and Link Canyon is known as an elk migration route, providing access to and from the winter range from the plateau top (See Plates 3-2 and 3-3 of the M&RP). The permittee is obligated to monitor and mitigate subsidence that poses a risk to livestock and wildlife as soon as feasibly possible. This will be done according to the subsidence monitoring plan (See Section 5.2.5.1) and migration commitments (See Sections 3.3.3.3 and 3.4.1.2) within the MRP. An effort will be made by the permittee to monitor subsidence between 60 and 90 days following completion of the 4R4E longwalll panel or as soon as access is feasible. The permittee recognizes that this time constraint commitment only apples to the 4R4E panel.

4 Right 4 East Panel - Greater Sage-Grouse

Data provided to the public by the Utah Division of Wildlife Resources (UDR) show approximately 30,000 acres of designated sage grouse habitat north of where the 4R4E panel is located. A small portion of the panel is located in this area, but the majority of the panel lies outside of the designated habitat boundary. After consulting with UDWR, Division (DOGM) personnel determined that the proposed 4R4E panel is not likely to have an impact on sage grouse lekking, nesting, or brood rearing activity.

4 Right 4 East Panel - Seed Mix Information

Should a seed mix be required to be used on soil filled subsidence cracks the seed mix previously used for the sinkhole repair and reclamation project will be used. See Section 3.4.1.2 for information regarding the sinkhole project seed mix. Soils used to fill subsidence cracks which receive seed will not receive mulch or fertilizer. Refer to Section 5.2.5.2 (Correction of Material Damage) for additional information.

Pines East Panel(s)

Although no subsidence is anticipate, should a seed mix be required to be used on soil filled subsidence cracks associated with the Pines East panels the 3Right 4 East Panel seed mix (See Section 3.4.1.2) will be used. Soils used to fill subsidence cracks which receive seed will not receive mulch or fertilizer. Refer to Sections 5.2.5 and 5.2.5.2 (Correction of Material Damage) for additional subsidence information.

The wildlife habitats above the panel(s) include critical elk winter range and high value elk and deer range (Plates 3-2, 3-3). The escarpment in the southeastern portion of the tract which lies between Quitchupah Canyon and Link Canyon is known as an elk migration route, providing transition to and from the winter range from the plateau top. There is no potential spotted owl habitat (Pines Tract Project FEIS, 1999). During a biological survey (Appendix 3-4, Tetra Tech June 2018) of the area done for surface exploration drill no new raptor nests were identified and the Northern Goshawk territory was deemed inactive. In addition the Tetra Tech Biologist detected no threatened, endangered or sensitive species in the area, including greater sage grouse. The panels are not within a known sage grouse lek and it was not verified if sage grouse travel through area above the panels. Utah Division of Wildlife Resources designated sage grouse habitat lies west and north of the panels.

Historic Raptor Nests information for the area:
322 (Eagle) - Dilapidated in 1998, not surveyed since
326 (Eagle) - Inactive 2001, 2007
327 (Eagle) - Dilapidated 2001, no surveyed since
801 (Eagle) - No found 1998
803 (Eagle) - Inactive 2001, 2007
804 (Eagle) - Tended 2001, not surveyed since
806 (Hawk) - Not surveyed 2001 thru 2006, Inactive 2007
810 (Eagle) - Not Found 1999, not surveyed since

The area of the Pines East panels will be surveyed for raptor again in 2019 and will continue to be surveyed as described in Section 3.3.3.3.

Pines Tract Project FEIS (1999) contains figures of Vegetation Types Figure 3-10 and Riparian Areas Figure 3-11.

Elk

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

Although the potential area of impact is not critical to the continued existence and perpetuation of the herd, it is important to maintenance of current population levels, and portions of the entire lease

identified in the Utah counties in which Sufco lies. However, this list does not necessarily indicate these species are found within the mine permit boundaries.

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

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

A discussion about threatened, endangered or otherwise sensitive plant and animal species of the Pines Tract Project area is given in Appendix 3-9. A discussion about threatened, endangered or otherwise sensitive plant and animal species of the Muddy Tract area is provided in the Cirrus report (Appendix 3-11). A discussion about threatened, endangered or otherwise sensitive plant and animal species of the West Coal Lease Modifications and the area od the 2016 2RWL sinkhole repair are summarized in Appendix 3-13 and Section 3.2.2.2.

Table 3-1
Federally Listed and Proposed Endangered Species in Utah
Sevier, Sanpete and Emery Counties
~~**April 2, 2013 (2016)**~~ November 1, 2017

Plants		Status	Present
Barneby Reed-Mustard	Schoenocrambe barnebyi	E	NP
Heliotrope Milk-Vetch	Astragalus montii	T	NP
Jones Cycladenia	Cycladenis humilis var. jonesii	T	
Last Chance Townsendia	Townsendia aprica	T	NP
~~San Rafael Cactus~~	~~Pediocactus despainii~~	~~E~~	~~NP~~
Wright Fishhook Cactus	Sclerocactus wrightiae	E	NP
Winkler Pincushion Cactus	Pediocactus winkleri	T	NP
~~Dwarf Bear-poppy*~~	~~Arctomecon humilis~~	~~E~~	~~NP~~
~~Kodachrome Bladderpod*~~	~~Lesquerella tumulosa~~	~~E~~	~~NP~~
~~Autumn Buttercup*~~	~~Ranunculus aestivalis (acriformia)~~	~~E~~	~~NP~~
Despain Pincushion Cactus	Pediocactus despainii	E	NP

Mammals

Utah Prairie Dog	Cynomys parvidens	T	NP
Canada Lynx	Lynx canadensis	T	NP
~~Desert Tortoise*~~	~~Gopherus agassizii~~	~~T~~	~~NP~~

Birds

Mexican Spotted Owl	Strix occidentalis lucida	T	NP
~~Southwestern Willow Flycatcher*~~	~~Empidonax traillii extimus~~	~~E~~	~~NP~~
~~Gunnison Sage-grouse*~~	~~Centrocersus minimus~~	~~T~~	~~NP~~
Western Yellow-billed Cuckoo	Coccyzus americanus	T	NP
~~Three-toed Woodpecker~~	~~Picoides ridactytus~~	~~S~~	~~P~~

Fish

Bonytail Chub	Gila elegans	E	NP
Colorado Pikeminnow	Ptychocheilus lucius	E	NP
Humpback Chub	Gila cypha	E	NP
Razorback Sucker	Xyrauchen texanus	E	NP
~~June Sucker*~~	~~Chasmistes liorus~~	~~E~~	~~NP~~
~~Greenback Cutthroat Trout*~~	~~Oncorhynchus clarki stomias~~	~~T~~	~~NP~~
~~Lahontan Cutthroat Trout*~~	~~Onxhohynchus clarkii henshawi~~	~~T~~	~~NP~~
~~Virgin River Chub*~~	~~Gila seminuda (robusta)~~	~~E~~	~~NP~~
~~Woundfin*~~	~~Plagopterus aregantissimus~~	~~E~~	~~NP~~

Amphibians & Reptiles & Snails

None listed in the Counties

~~Snails~~

~~Kanab Ambersnail*~~	~~Oxyloma haydeni kanabensis~~	~~E~~	~~NP~~

E - Endangered T - Threatened Extirpated - No longer occur in Utah C - Candidate
NP - Not Present (BLM, USFWS, FSEIS) P - Present (BLM, FSEIS)

For additional information contact: U. S. Fish and Wildlife Service, ~~2078 Administration Building, 1745 West 1700 South, Salt Lake City, Utah 84204-5110~~ Telephone:(801) 975-3300

3.2.3.3 Facilities for Protection and Enhancement

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

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

3.2.3.4 Vegetation Type and Plant Communities

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

Table 3-2

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

~~October 1, 2015~~ November 1, 2017

Mammals		**State Status**
Brown (Grizzly) Bear- Historically	Ursus arctos	S-ESA (S,SV)
Black-footed Ferret- Unconfirmed	Mustela nigripes	S-ESA (E)
Utah Prairie Dog	Cynomys parvidens	S-ESA (S,SV)
Fringed Myotis	Myotis thysanodes	SPC (SV)
Big Free-tailed Bat	Nyctinomops macrotis	SPC (SV)
Townsend's Big-eared Bat	Plecotus townsendii	SPC (E,S,SV)
Canada Lynx - Possibly/Historically	Lynx canadensis	S-ESA (E,S,SV)
Kit Fox	Vulpes macrotis	SPC (E,S,SV)
White-tailed Prairie-dog	Cynomys leucurus	SPC (E)
Pygmy Rabbit	Brachylagus idahoensis	SPC (SV)
Birds		
~~Southwestern Willow Flycatcher~~	~~Empidonax traillii extimus~~	~~S-ESA~~
Bald Eagle	Haliaeetus leucocephalus	SPC (E,S,SV)
Ferruginous Hawk	Buteo regalis	SPC (E,S,SV)
~~Yellow-billed Cuckoo~~	~~Coccyzus americanus occidentalis~~[3]	~~S-ESA~~

~~Spotted (Mexican) Owl~~	~~Strix occidentalis~~[2]	~~S-ESA~~
Northern Goshawk	Accipiter gentilis	CS (E,S,SV)
Burrowing Owl	Athene cunicularia	SPC (E,S,SV)
Short-eared Owl	Asio flammeus	SPC (SV)
American White Pelican	Pelecanus erythrorhynchos	SPC (SV)
Three-toed Woodpecker	Picoides tridactylus	SPC (S,SV)
Greater Sage-Grouse	Centrocercus urophasianus	SPC (E,S,SV)
Long-billed Curlew	Numenius americanus	SPC (S,SV)
Black Swift	Cypseloides niger	SPC (SV)
Lewis's Woodpecker	Melanerpes lewis	SPC (S)
Grasshopper Sparrow	Ammodramus savannarum	SPC (S)
Fish		
Bonytail	Gila elegans	S-ESA (E)
Humpback Chub	Gila cypha	S-ESA (E)
Razorback Sucker	Xyrauchen texanus	S-ESA (E)
Roundtail Chub	Gila robusta	CS (E)
Flannelmouth Sucker	Catostomus latipinnis	CS (E)
Bluehead Sucker	Catostomus discobolus	CS (E,S)
Colorado River Cutthroat Trout	Oncorhynchus clarki pleuriticus	CS (E,S,SV)
Bonneville Cutthroat Trout	Oncorhynchus clarki utah	CS (S,SV)
Colorado Pikeminnow	Ptychocheilus lucius	S-ESA (E)
Southern Leatherside Chub	Lepicomeda aliciae	SPC (S,SV)
Reptiles and Amphibians		
Western (Boreal) Toad	Bufo boreas	SPC (E,S,SV)
Great Plains Toad	Bufo cognatus	SPC (E)
Columbia Spotted Frog	Rana luteiventris	CS (S)
Mollusk		
Carinate Glenwood Pyrg	Pyrgulopsis inopinata	SPC (SV)

Otter Creek Pyrg	Pyrgulopsis fusca	SPC (SV)
Smooth Glenwood Pyrg	Pyrgulopsis chamberlini	SPC (SV)
Ninemile Pyrg	Pyrgulopsis nonaria	SPC (S)
South Bonneville Springsnail	Pyrgulopsis transversa	SPC (S)

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

Key to State Status Field (Table 3-2)

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

Utah Division of Wildlife Resources, 1596 West North Temple, Salt Lake City, Utah 84116-3195

Utah Natural Heritage Program's Biodiversity Tracking and Conservation System (BIOTICS)

Table 3-3

USDA-FS Region 4 Sensitive Species - Fishlake and Manti-LaSal

February 2013 Update (June 2016)

Plants		**Status**	**Present**
Link Trail Columbine*	Aquilegia flavescens var. rubicunda	K	NP
Cruetzfeldt-flower Cryptanth*	Cryptantha creutzfeldii	K	NP
Carrington Daisy*	Erigeron carringtoniae	K	NP
Canyon Sweetvetch*	Hedysarum occidentale var. canone	K	NP
Maguire Campion*	Silene petersonii	K/P	NP
Musinea Groundsel	Senecio musinensis	K	NP
Arizona Willow*	Salix arizonica	K	NP

Wonderland Alice Flower*	Aliciella caespitosa	K	NP
Chatterley Onion*	Allium geyeri var. chatterleyi	K	NP
Sweet-flower Rock Jasmine*	Androsace chamaejasme ssp. Carinata	K	NP
Bicknell Milkvetch*	Astragalus consobrinus	K/P	NP
Isely's Milkvetch*	Astragalus iselyi	K	NP
Desert Milkvetch*	Astragalus desereticus	K	NP
Tushar Paintbrush*	Castilleja parvula var. parvula	K	NP
Pinnate Spring-parsley*	Cymopterus beckii	K	NP
Abajo Peak Draba*	Draba abajoensis	K	NP
Mt. Belknap Draba*	Draba ramulosa	K	NP
Creeping Draba*	Draba sobolifera	K	NP
Nevada Willowherb*	Epilobium nevadense	K	NP
Abajo Daisy*	Erigeron abajoensis	K	NP
Kachina Daisy*	Erigeron kachinensis	K	NP
Maquire Daisy*	Erigeron maguirei	K	NP
LaSal Daisy*	Erigeron mancus	K	NP
Elsinore Buckwheat*	Eriogonum batemanii var. ostlundii	K	NP
Canyonlands Lomatium*	Lomatium latilobum	K	NP
Fish Lake Naiad*	Nafas caespitosa	K	NP
Beaver Mountain Groundsel*	Packera castoreus	K	NP
Little Penstemon*	Penstemon parvus	K	NP
Ward Beardtongue Penstemon*	Penstemon wardii	K	NP
Bicknell Thelesperma*	Thelesperma subnudum var. alpinum	K	NP
Barneby Woody Aster*	Tonestus kingii var. barnebyana	K	NP
Sevier Townsendia*	Townsendia jonesii var. lutea	K	NP
San Rafael Cactus*	Pediocactus despainii	K	NP
Clay Phacelia*	Phacelia argillacea	P	NP
Last Chance Townsendia*	Townsendia aprica	K	NP
Ute Ladies'Tresses Orchid*	Spiranthes diluvialis	K	NP
Heliotrope Milk-Vetch*	Astragalus montii	P	NP
Winkler Cactus*	Pediocactus winkleri	K	NP
Desert Milk-Vetch*	Astragalus desereticus	K	NP

Mammals

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

K - Known distribution species and or habitat

P - Suspected species or potential habitat NP- Not Present (BLM FSEIS)

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

CHAPTER 4

LAND USE AND AIR QUALITY

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

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

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

Pines East Panels - The area has been previously subject to many cultural resource inventories. Sites recorded within the search area are documented in inventories of the Pines Area located in Confidential-Appendix 4-2 (AERC, Pines Locality 11/2/1997). SHPO clearance for the Pines East Panels is being sought in 2018/2019 following a review by the USFS and DOGM, see Appendix 4-2 for documentation of the clearance. Site 42SV2426 is the only prehistoric site in the immediate area of the panels and is considered insignificant. Site 42SV2426 consists of a lithic scatter of debitage (flakes, scraper, a projectile point fragment) on the rim of the Wasatch Plateau. As expected the artifacts scatter as encountered was isolated, sparse and of low complexity. In 2018 portions of Sections 13, 24 and 25 of T21S, R5E (Figure 2) were inventoried in association with an exploration drilling project, no artifacts or cultural resources were encountered. The inventory report has been incorporated into Appendix 4-2 (Tetra Tech July 2018).

CHAPTER 5

ENGINEERING

- No subsidence or caving operations will be conducted to affect any portion of the right-of-way of this road within 100 feet of the underground entry system,
- Surface activities will be conducted in a manner that will not block the road, and
- Water bars have been constructed on that portion of the road bordering the disturbed area adjacent to the mine surface facilities. Regular inspections of that portion of the road are conducted by mine personnel to ensure that erosion does not become a problem. In the event that material damage due to erosion as a result of mining activities is discovered on or along the side of this road, SUFCO Mine will repair this damage and implement additional runoff-control measures as needed.

Subsidence from underground mining operations may affect public-access dirt roads throughout the lease and permit areas . As part of the subsidence monitoring program, these roads will be regularly inspected. If material damage occurs to these roads as a result of mine subsidence, the roads will be repaired by SUFCO Mine.

Mining Sequence and Planned Subsidence. The mine plan for the SUFCO Mine is presented in Plate 5-7 (Upper Hiawatha seam) and Plate 5-8 (Lower Hiawatha seam). These maps show the boundaries of all areas proposed to be affected over the estimated total life of the coal mining and reclamation operations, including the size, sequence, and timing of mining of subareas to be affected beyond the present permit term. No surface disturbances are currently anticipated within the permit area beyond that presented in this M&RP.

Plates 5-7 and 5-8 also shows the location and extent of underground workings in which planned-subsidence mining methods will be used as well as areas where measures will be taken to prevent, control, or minimize subsidence and subsidence-related damage. The location of the waste-rock disposal area in relation to the underground mine workings, is discussed in Volume 3 of this M&RP.

Pines East Panels located in the Pines Lease will be mined using the First Mining/Room & Pillar method, no subsidence is projected with this method. Due to no subsidence, monitoring is not planned for these panels.

- Pre-mining analysis of drill-hole data allows estimates to be made of the nature, depth, and thickness of the coal seam and associated partings. Using these data, the mine plan and mining methods are evaluated and amended as necessary to maximize coal recovery.
- Experience gained during mining is used to amend future mine plans if coal recovery can be increased.
- The mine converted from an exclusive room-and-pillar extraction method to a combination of room-and-pillar and longwall extraction methods in October 1985. As a result of this conversion, coal recovery at the mine increased from approximately 75 percent under exclusive room-and-pillar methods to 88 percent under the combined room-and-pillar and longwall methods.

The mine layout has been planned relative to panels, barriers, and pillars to optimize both coal recovery and safety using a combination of longwall and room-and-pillar mining techniques.

An evaluation of geologic data collected in the southern portion of lease U-28297 indicates that the Upper Hiawatha seam in this area contains a paleochannel system and associated parting. The parting attains a thickness in excess of 20 feet and occurs in a northeast-southwest trending band varying in width from 2,000 feet to 7,500 feet. Because of this parting, most of the southern portion of lease U-28297 is deemed unminable from both technological and economic viewpoints.

Mining is not planned on parts of the extreme east and southeast portions of the Pines Tract Lease UTU-76195 as a result of poor quality and seam height. A parting located in the middle of the seam, will not allow mining to occur at the minimum height without putting quality at unacceptable levels. Much of the seam height in these areas is between 4-6 feet. Reserves are also lost to burn in these areas as a result of several promontories in the area which allow greater exposure of the outcrop to the atmosphere.

Upper Hiawatha coal seam. Overburden ranges approximately from 300-900 feet. The projected subsidence across the 4R4E panel ranges from 1 -5 feet and the projected average subsidence is approximately 2 feet. See the 4R4E Projected Subsidence Map in Appendix 6-4. No surface disturbance, new surface facilities or infrastructure will be associated with the mining of the 4R4E panel therefore no bonding will be needed.

Pines East Panel(s)

Mining of these panels will occur in Lease UTU-76195 which is referred to as the Pines Tract throughout the M&RP in text, appendices and on drawings. This lease was issued to the permittee in October 1999 (Appendix 1-2), portions of the lease were relinquished in 2016 (Appendix 1-1). See Plate 5-6 and Plate 5-7 for the mine plan and respective timing. Mining will occur only in the Upper Hiawatha coal seam. Overburden ranges approximately from 750-1000 feet. ~~The projected subsidence across the panels is 5 feet or less. Subsidence control points have been previously established near the panels (Table 5-2).~~ The panels will be mined using the First Mining/Room & Pillar method, no subsidence is projected with this method. No surface disturbance, new surface facilities or infrastructure will be associated with the mining of the panels.

5.2.5.1 Subsidence Control Plan

Potential Areas of Subsidence. Structures that are present above the existing or planned mine workings that may be affected by mining are shown on Plate 5-5. Renewable resource lands within the lease and permit areas are shown on Plates 4-1 A, B, C, 5-10C, 7-2 and 7-3. Two subsidence monitoring locations were added in 2017, one west of the Greens Hollow lease(#2251), the second is within the Greens Hollow lease (#2250), additional subsidence monitoring locations will be added as mining progresses to the north.

Green Hollow. Various information for the Greens Hollow Lease is located in Appendix 7-27 and the renewable resource lands plates listed above. The Greens Hollow area contains troughs, stock and natural ponds which may be affected by subsidence. They are shown on drawing in this appendix under divider "Natural and Stock Ponds" The area of the Greens Hollow lease is not known to contain non-commercial buildings; public buildings and facilities; churches; schools; hospitals; occupied residential dwellings or related structures. The Rough Brothers cabin the only

CHAPTER 6

GEOLOGY

3 Right 4 East Panel(s)

Refer to Section 5.2.1.1 for reference to various maps, including those containing topography of the 3 Right 4 East panel. Additional geology maps requested by the Manti-La Sal forest geologist are located in Appendix 6-4 (Confidential). The maps are of subsidence, geology and overburden superimposed over the panel(s) mine plan and cross-sections of longwall panel within the coal seam. The information on the geology maps within Appendix 6-4 with the label "Panel 3R4E" are specific and more comprehensive than generalized information presented within this chapter.

4 Right 4 East Panel(s)

The 4R4E panel is located within Lease U-63214 which is referred to as the Quitchupah Tract. This tract is located within the southern region of the Wasatch Plateau which lies with the Basin and Range-Colorado Plateau Province. The topography of the tract consists of a flat plateau that is deeply dissected by narrow canyons., The coal seams crop out in the southeastern portion of the tract along the steep escarpments of Quitchupah Canyon, Dry Fork Canyon, East Fork Canyon and Link Canyon, The 4R4E panel is located in Dry Fork Canyon. See Appendix 5-14, Plate 5-6 and Plate 5-7 for the 4R4E mine plan, lease locations and mine timing respectively. Mining will occur only in th Upper Hiawatha coal seam. Overburden ranges approximately from 300-900 feet. The projected subsidence across the 4R4E panel ranges from 1-5 feet and the projected average subsidence is approximately 2 feet. See the 4R4E Projected Subsidence Map in Appendix 6-4.

The Applicant has a Resource Recovery and Protection Plan (R2P2) on file with the Bureau of Land Management. This R2P2 contains a detailed description of the two mineable coal seams on the SUFCO Mine leasehold. The overlying Duncan Seam is not considered mineable (see Section 5.2.2).

Pines East Panel(s)

The panel is located within Lease UTU-76195 which is referred to as the Pines Tract. This tract is located within the southern region of the Wasatch Plateau which trends north and south. The topography of the tract consists of a flat plateau that is deeply dissected by narrow incised canyons. Generally canyon walls are steep and canyon bottoms are narrow. The overburden ranges approximately from 750-1000 feet. Geologic units in the area on the plateu include the Price River Formation, small areas of the Castlegate Sandstone Formation and the Blackhawk Formation - Upper Member and Blackhawk Formation - Starpoint Sandstone member in the canyons.

CHAPTER 7

HYDROLOGY

7.2.4.1 Groundwater Information

This section presents a discussion of baseline groundwater conditions in the mine area. A discussion of the groundwater conditions in the SUFCO leased area is presented in this section and appended by Appendix 7-17. A discussion of groundwater conditions in the Pines Tract is presented in Appendix 7-18 of this Chapter. A discussion of groundwater conditions in the West Coal Lease Modifications is presented in Appendix 7-24 of this Chapter and in Appendix7-25, Attachment A for the Northwater wells. A discussion of groundwater conditions at the waste rock disposal site is provided in Waste Rock Volume of this M&RP.

The locations of wells and springs in the mine area are presented on Plate 7-3. The wells in the mine area are all water monitoring wells, not water supply wells. Water rights for the mine and adjacent areas are addressed in Section 7.2.2.2 of this M&RP. With the exception of the potable use of source 94-87 by SUFCO, all other groundwater use (seeps and springs) is confined to stock watering. The hydrology in the area of the 2RWL sinkhole are discussed in the PHC located in Appendix 7-24.

Greens Hollow. Appendix 7-27 contains selected water monitoring data for the Green Hollow Tract. The appropriated water rights within the Greens Hollow Lease belong to the USFS. The PHC for the Greens Hollow Lease is located in Appendix 7-28.

AQUIFERS

Geologic conditions in the permit and adjacent areas are described in detail in Chapter 6 of this M&RP. Groundwater occurrences within the permit and adjacent areas occurs predominantly in the Blackhawk Formation and Star Point Sandstone. However, perched aquifers of limited areal extent are present in the geologic formations. Hydrogeologic conditions within the permit and adjacent areas are summarized below. Refer to the PHC's in Appendices 7-17 thru 7-20, 7-24, 7-26, 7-28 for more specific information.

North Horn Formation. The North Horn Formation crops out in the northwest portion of the lease area. This formation consists of interbedded shale, sandstone, and limestone. Data presented in Appendix 7-2 indicate that only one seep and one spring issue from the North Horn Formation within the lease area. Recharge occurs to outcrops of the North Horn Formation west of the lease

groundwater (more than 2 gpm) were encountered in any of the exploration holes nor was groundwater identified in all drill holes.

Of the observation wells completed in the Castlegate Sandstone, two (US-77-9 and 89-16-1W) have been dry during their entire period of record. Two additional wells (US-77-8 and 89-20-2W) have only a brief period of record (due to lack of water or time since installation, respectively). Hydrographs of the remaining two Castlegate Sandstone observation wells (US-80-2 and US-80-4) are presented in Figure 7-2. Water-level data for all wells are provided in Appendix 7-3. Seasonal fluctuations of groundwater levels in these wells have typically been less than one foot.

Coal exploration holes drilled in and near the Pines Tract by the USGS, have geophysical logs indicating similar conditions for the Castlegate Sandstone. Exploration Hole W-TP-4-EW found fluids present at a depth of 82 feet below ground surface, within the Castlegate Sandstone. Exploration holes W-TP-3-EW and W-TP-2-EW did not encounter fluids within the Castlegate Sandstone. Exploration drilling (2018) completed in the Pine East Panel area encountered no water within the holes drilled: 8-13-1, 18-24-1, 18-124-2, 18-24-3 and 18-25-1(locations shown on Plate 6-1). Monitoring well NW4-09 is discussed in Appendix 7-25 , Attachment A.

This formation is not considered to be a significant regional aquifer. It is assumed that the groundwater occurrence within the Castlegate Sandstone is limited to isolated perched zones contained in the more permeable sandstone lenses or within weathered bedrock and fractures/joints at and near the escarpments within Box Canyon. Because groundwater occurrence within the Castlegate Sandstone is not continuous over the permit and adjacent areas, no potentiometric surface could be developed for the unit.

The data presented in Figure 7-2 indicate a downward trend in static water levels for the Castlegate Sandstone. This trend is most probably due to decreased precipitation during the last several years. A discussion of climatic conditions in the permit and adjacent areas is provided in Section 7.2.4.4 of this M&RP.

Groundwater recharge to the Castlegate Sandstone is from precipitation and snowmelt. Over much of the area, the Castlegate Sandstone and the remainder of the Price River Formation form

7.3.1.2 Water Monitoring

Groundwater Monitoring. Groundwater monitoring is proposed to be conducted in the SUFCO permit and adjacent areas according to the water monitoring plans presented in Tables 7-2 through 7-5A and for the rock waste disposal site in Section 731 in Waste Rock Volume of this M&RP. These tables are based on the studies done by Mayo and Associates (Appendices 7-17 and 7-18) and supersede previous plans.

The location of the monitoring points are presented on Plate 7-3 and 7-10. The location of the monitoring wells for the rock waste disposal site are presented on Map 5A, Waste Rock Volume of this M&RP. The monitoring plans were developed based on information presented in the PHC determinations, the baseline hydrologic data, and the geology chapter of this M&RP.

The monitoring programs provide data that are reviewed and compared to the baseline data. Any significant changes are evaluated to determine their impact on the hydrologic balance. These comparisons have taken the form of reports prepared by Hydrometrics early in the permit term (1978-1987). Results of these evaluations are submitted periodically to the UDOGM. The annual Water Quality Report submitted to the Division contains the monitoring data.

Baseline data collected for the Pines Tract area included performing field surveys to identify existing springs. Additionally, springs identified in the USGS publication "Hydrology and Effects of Mining in the Quitchupah and Pines -Coal Lease Tracts, Central Utah " (Thiros and Cordy, 1991) were searched for and, when found, included in the baseline survey. Those springs identified and found within the Pines Tract in the above referenced publication are labeled on Plate 7-3 with the prefix "GW - ". During the baseline surveys, several springs identified in the publication could not be found as illustrated on the document maps or by using the printed location descriptions. It is assumed the springs that could not be found have a) stopped flowing; b) were miss mapped; or c) were in close proximity to springs found during the baseline surveys but could not be positively identified as USGS located springs and were therefore given new number designations.

Pines East Panel(s) - The closest historical quarterly groundwater monitoring locations are springs GW-21 and Pines 100 located in Link Canyon. Pines 101 spring was monitored twice in 1997 and is located approximately 0.2 mile from the potential area of subsidence (Plate 7-3). A report has been included which discusses Pines 310 a spring northeast of the panels and spring

GW-21 located east of the panels (Appendix 7-18). Pines 310 spring was previously mined beneath and is part of a migration project completed by the Permittee. Water right spring 94-591 will be added to the monitoring plan in 2019 and monitoring will cease in 2023 following mining of the Pines East panels. The table below provides water sampling information for springs and surface water locations contiguous to the mining panels.

Pines East Panels - Water Sampling

Sampling Locations	Years Monitored	No. of Samples	Flow Max	Flow Average	Subsided	Miles from Panels (Approx.)
Groundwater						
GW-21*	1979/1995 - Present	67	2.29	0.33	N	0.2
Pines 100*	1997/2000 - Present	55	0.96	0.22	N	0.2
Pines 310*	1997/2006 - Present	41	5.36	0.7	Y	1.0
Pines 311*	1997/2006 - Present	39	1.26	0.07	Y	1
Link Portal East	2002 - Present	46	0.06	0.0015	N	0.57
Link Portal West	2003 - Present	44	0	0	N	0.57
Pines 101*	1997	2	0.02	0.01	N	0.19
Pines 102*	1997	2	0.17	0.08	N	0.24
Pines 103*	1997	2	0.18	0.1	Y	1
Surface Water						
Link 001	2003 - Present	44	0.2	0.004	N	0.57
Link 002	2005 - Present	44	0	0	N	1

* Issue from Castlegate Sandstone

Monitoring data for groundwater sampling locations GW-21, Pines 100, Pines 310, Pines 311, Link Portal East, and Link Portal West are available for review in the DOGM Water Database.

Baseline data collected for the Muddy Tract area is located in the "Coal Tract Evaluations on the Manti-La Sal National Forest" report prepared for the Manti-La Sal National Forest by Cirrus Ecological Solutions, LC. Those springs identified and found within the Muddy Tract in the above referenced publication are labeled on Plate 7-3 with the prefix "M- ".

Sampling for the SUFCO Mine and adjacent areas is accomplished in accordance with the schedule outlined on Tables 7-2 through 7-5A. Sampling for the waste rock disposal site is

TABLE 7-2
Water Monitoring Program

Monitoring Wells	Protocol	Comments
US-80-2	A	Screened in Castlegate Sandstone
US-80-4	B	Screened in Castlegate Sandstone
89-20-2W	A	Screened in Castlegate Sandstone
	Protocol	Comments
US-79-13	B	Screened in Blackhawk Formation
US-81-3	A	Screened in Blackhawk Formation
US-81-4	A	Screened in Blackhawk Formation
01-8-1	A	Screened in Blackhawk Formation
MW-15-5-2	A	Screened in Castlegate Sandstone
NW4-09***	A	Screened in Castlegate Sandstone
In-mine Well (Proposed)	A	Screened in Starpoint Sandstone

~~**TABLE 7-2 (Continued) Water Monitoring Program**~~

Streams		
SUFCO 006	C,2	Upper South Fork Quitchupah Creek
SUFCO 006D	F,1	Upper South Fork Quitchupah Creek
SUFCO 007 (North Fork Lower)	C,2	Upper North Fork Quitchupah Creek
SUFCO 041	C,2	Lower Quitchupah Creek
SUFCO 042	C,2	Lower North Fork Quitchupah Creek
SUFCO 046	C,2	Upper Quitchupah Creek
SUFCO 047A	C,2	Lower East Spring Canyon Creek
SUFCO 090	C,1	Upper Box Canyon Creek
Pines 106	C,2	Upper East Fork Box Canyon
Pines 302	C,1	Muddy Creek-Last Water Creek Confluence
Pines 403	C,2	Lower Box Canyon Creek
Pines 405	C, 2	Muddy Creek - Box Creek Confluence
Pines 406	C,1	Lower Muddy Creek
Pines 406b*	C,1	Lower Muddy Creek
Pines 407	C,1	Box Canyon Creek
Pines 408	C,1	East Fork Box Canyon Creek
USFS-109	C,1	Upper Main Fork of Box Canyon Creek
Link 001	C,2	Link Canyon Drainage
Link 002	C,2	Link Canyon Drainage
FP-1	G,6	East Fork of Main Fork of Box Canyon
FP-2	G,6	East Fork of East Fork of Box Canyon

GW-21	D,3	Castlegate Sandstone
Pines 100	D,4	Castlegate Sandstone
Pines 105	D,3	Castlegate Sandstone
Pines 206	D,5	Blackhawk Formation
Pines 209	D,5	Blackhawk Formation
Pines 212	D,5	Blackhawk Formation
Pines 214	D,5	Blackhawk Formation
Pines 218	D,3	Castlegate Sandstone
Pines 303	D,3	Blackhawk Formation
Pines 310	D,7	Castlegate Sandstone
Pines 311	D,7	Castlegate Sandstone
Link Portal-West	D,4	Link Canyon Portal

TABLE 7-2 (Continued) Water Monitoring Program

Springs	Protocol	Comments
Link Portal-East	D,4	Link Canyon Portal
M-SP01	D,3	Price River Formation
M-SP02	D,3	Price River Formation
M-SP04	D,9	North Horn Formation
M-SP05	D,9	North Horn Formation
M-SP06	D,9	North Horn Formation
M-SP08	D,3	North Horn Formation
M-SP09	D,9	North Horn Formation
M-SP11	D,9	North Horn Formation
M-SP12	D,9	North Horn Formation
M-SP15	D,9	North Horn Formation
M-SP18	D,3	Price River Formation
M-SP19	D,9	North Horn Formation
M-SP20	D,9	North Horn Formation
M-SP39	D,3	Price River Formation
M-SP40	D,9	North Horn Formation
M-SP41	D,9	North Horn Formation
M-SP44	D,9	North Horn Formation
M-SP45	D,9	North Horn Formation
M-SP53	D,3	North Horn Formation
M-SP60	D,9	North Horn Formation
M-SP87	D,9	Price River Formation
M-SP100	D,9	North Horn Formation

M-SP103	D,9	North Horn Formation
M-SP104	D,9	North Horn Formation
M-SP105	D,9	North Horn Formation
M-SP106	D,9	North Horn Formation
Mud Spring	D,5	Price River Formation
Broad Hollow	D,5	Blackhawk Formation
USP-2	D,9	Price River Formation
94-591***	D,3	Castlegate Sandstone

Springs	Protocol	Comments
Wedge Spring	H,3	Castlegate Sandstone
Amanda Spring	H,3	Castlegate Sandstone
94-113 Seep	H,3	Price River Formation

*** Added to the monitoring plan in 2019 and monitoring will cease following the 4th Quarter of 2024 after mining of the Pines East panels.

Monitoring point 406B is located at an old USGS monitoring location (circa 1999) located in the NW1/4NE1/4, Sec. 21, T21S. R6E.

Should a spring listed in Table 7-2 change locations, the Division will be notified in the note section during the entry of the quarterly data into the Division's database.

TABLE 7-3
Field and Laboratory Measurement Protocol
Water level and flow measurements

A	Monitoring well:	quarterly water level measurement (3 quarters per year)
B	Monitoring well:	annual water level measurement (3rd quarter)
C	Stream:	quarterly discharge measurements
D	Spring:	quarterly discharge measurements
E	Spring Pool:	quarterly water level measurement
F	Stream:	Bi-weekly measurements while mining is occurring under the stream in 2013, thereafter quarterly for two years.
G	Stream:	Identify perennial portion of stream on or near October 1 of each year.
H	Spring:	Quarterly measurements while mining is occurring under the 2R2S panel stream in 2013, thereafter quarterly for two years.

- Mayo did not include dissolved iron and dissolved manganese in the operational monitoring plan because iron and manganese do not readily exist in dissolved form in basic (pH>7) waters but exist instead as hydroxide complexes. All waters in the leased area are basic. Measurements of total iron and manganese quantify both the dissolved and complex forms of these elements.

Equipment, structures, and other devices used in conjunction with monitoring the quality and quantity of the surface water in the permit and adjacent areas have been installed, maintained, and operated in accordance with accepted procedures. This equipment will be removed by SUFCO when no longer needed.

Pines East Panel(s) - Monitoring data for surface water sampling locations Link 001 and 002 in the Link Canyon drainage are available for review in the DOGM Water Database. Due to the ephemeral nature of the canyon's drainage and the lack of accessibility in a storm when the drainage would flow, a sample from Link 002 has never been collected. Refer to Section 7.2.4.2 for additional information pertaining to the Link Canyon drainage.

Stock Water Ponds

Several stock watering ponds are located in the Pines Tract and Quitchupah Lease area. The ponds are identified as Big Ridge South Draw, Big Ridge East Draw, Box, Jensen, Johnson, Rock, Dry Point, Joes Mill, Slab and Verdus. The stock ponds are located either within the lease area or within one-half mile of the lease area. Surface cracking due to mining related subsidence within the Quitchupah Lease has apparently adversely affected a few of the ponds. Action has been taken by SUFCO in the past to mitigate the damage, including applying bentonitic seals to the pond floors and hauling water for livestock. However, ranchers and State and Federal agencies have erroneously claimed that subsidence has adversely affected several ponds outside of the mining areas. In order to more adequately monitor the effects of mining on the stock watering ponds, SUFCO has been negotiating with DOGM, USFS, and the local rancher's association to create a workable monitoring plan for the ponds that can be agreed upon by all participants. DOGM has taken the lead in this process, and as of May 2000, a plan had not yet been finalized. In the interim, SUFCO commits to visiting the ponds within

Disposal of noncoal mine waste is discussed in Chapter 5.

7.4.8 Casing and Sealing of Wells

Each water well has been cased, sealed, or otherwise managed, as approved by the UDOGM, to prevent acid or other toxic drainage from entering ground or surface water, to minimize disturbance to the hydrologic balance, and to ensure the safety of people, livestock, fish and wildlife, and machinery in the permit and adjacent area. The drill logs and completion diagrams for the water wells are contained in Appendix 6-1 and 7-25 for the Northwater well(s).

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the UDOGM.

7.50 Performance Standards

All mining and reclamation operations will be conducted to minimize disturbance to the hydrologic balance within the permit and adjacent areas, to prevent material damage to the hydrologic balance outside the permit area and support approved postmining land uses.

7.5.1 Water Quality Standards and Effluent Limitations

Discharges of water from disturbed areas will be in compliance with all Utah and federal water quality laws and regulations and with effluent limitations for coal mining contained in 40 CFR Part 434.

7.5.2 Sediment Control Measures

All sediment control measures will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 7.3.2, 7.4.2, and 7.6.0.

7.5.2.1 Siltation Structures and Diversions

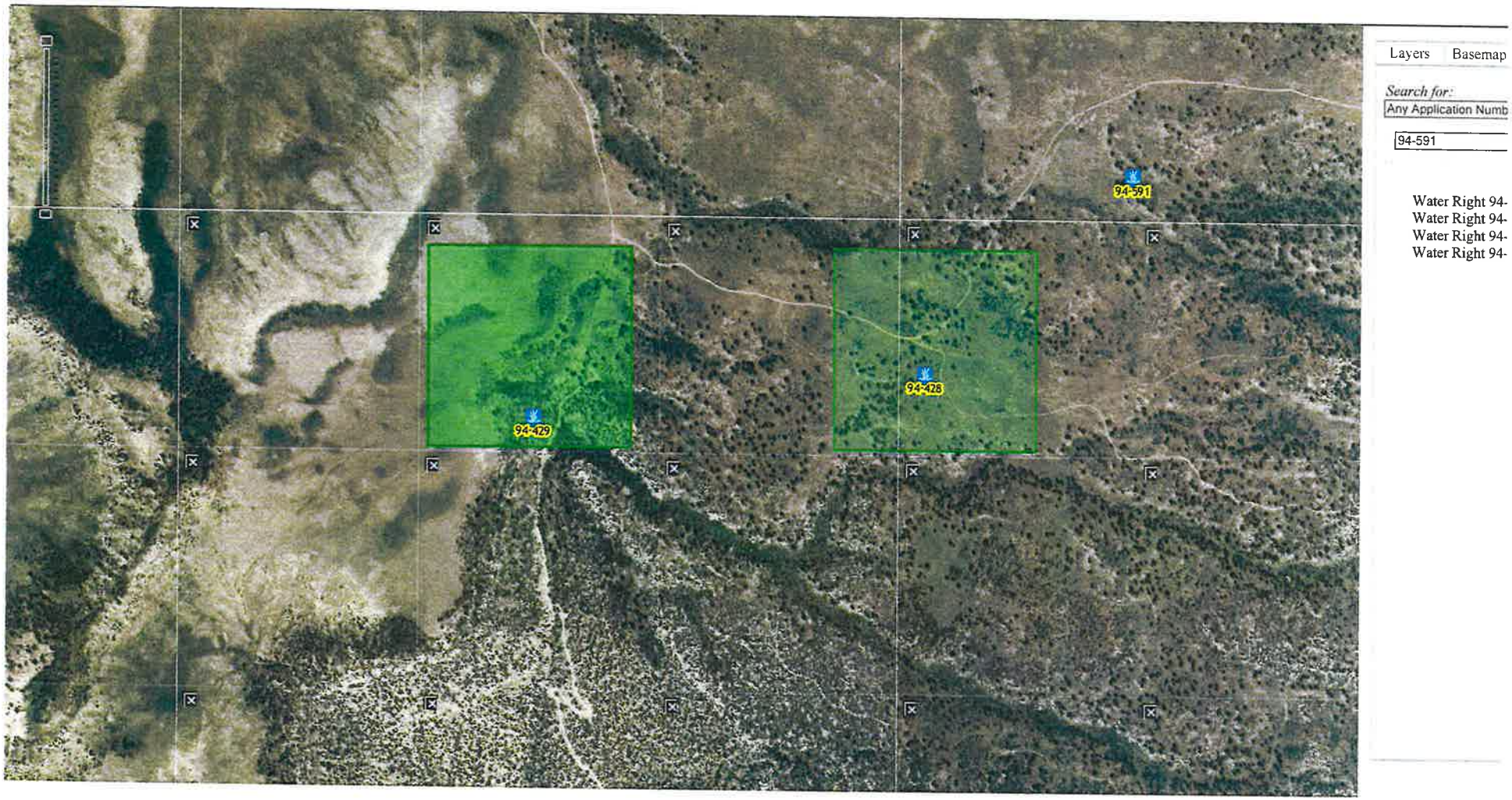
Siltation structures and diversions will be located, maintained, constructed and reclaimed according to plans and designs presented in Sections 7.3.2, 7.4.2, and 7.6.3.

7.5.2.2 Road Drainage

APPENDIX 7-1

Water Rights Data

Agencies


Layers
Basemap
Search for:
Any Application Numb
94-591
Water Right 94-
Water Right 94-
Water Right 94-
Water Right 94-
94-591
94-428
94-429

Water Right Details for 94-428

Utah Division of Water Rights

11/8/2018 9:05 AM

(WARNING: Water Rights makes NO claims as to the accuracy of this data.)

Water Right: 94-428 Application/Claim: Certificate:

Changes:

a36154 (Filed: 12/21/2009) Lapsed

Owners:

Name: USA Forest Service
Address: 324 - 25th Street
Ogden UT 84401

Interest: 100%

Remarks:

General:

Type of Right: Diligence Claim Source of Info.: Proposed Determination Status: Water User's Claim
Quantity of Water: 0.011 CFS
Source: Link Canyon Spring #1
County: Sevier
Common Description:
Proposed Det. Book: 94-1 Map: * Pub. Date:
Land Owned by Appl.: County Tax Id#:
Distribution System:

Dates:

Filing:
Filed: 08/07/1981 Priority: / /1879
Advertising:
Publication Began: Publication End: Newspaper:
Protest End Date: Protested: Not Protested Hearing Held:
Approval:
State Eng. Action: Action Date:
Recon. Req. Date: Recon. Req Action:
Certification:
Proof Due Date: Extension Filed Date:
Election or Proof: Election/Proof Date:
Certificate Date: 08/07/1981 Lapsed, Etc. Date: Lapsed Letter
Wells:
Prov. Well Date: Well Renov. Date:

Points of Diversion:

Points of Spring:
(1) N 500 ft. W 2050 ft. from SE corner, Sec 23 T 21S R 5E SLBM
Diverting Works: Source:
Elevation: UTM: 471945.651, 4313431.532

Water Uses:

Water Uses - Group Number: 618240

Water Rights Appurtenant to the following use(s):

94-417(WUC), 94-418(WUC), 94-419(WUC), 94-420(WUC), 94-421(WUC),
94-422(WUC), 94-423(WUC), 94-424(WUC), 94-426(WUC), 94-427(WUC),
94-428(WUC), 94-429(WUC), 94-430(WUC), 94-431(WUC), 94-432(WUC),
94-433(WUC), 94-434(WUC), 94-435(WUC), 94-436(WUC), 94-437(WUC),
94-438(WUC), 94-439(WUC), 94-440(WUC), 94-441(WUC), 94-442(WUC),
94-443(WUC), 94-444(WUC), 94-445(WUC), 94-446(WUC), 94-447(WUC),
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94-453(WUC), 94-454(WUC), 94-455(WUC), 94-456(WUC), 94-457(WUC),
94-458(WUC), 94-459(WUC), 94-460(WUC), 94-462(WUC), 94-463(WUC),
94-464(WUC), 94-465(WUC), 94-466(WUC), 94-467(WUC), 94-468(WUC),
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94-474(WUC), 94-475(WUC), 94-476(WUC), 94-477(WUC), 94-478(WUC),
94-479(WUC), 94-480(WUC), 94-481(WUC), 94-482(WUC), 94-483(WUC),
94-484(WUC), 94-485(WUC), 94-486(WUC), 94-487(WUC), 94-488(WUC),
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94-494(WUC), 94-495(WUC), 94-496(WUC), 94-497(WUC), 94-498(WUC),
94-499(WUC), 94-500(WUC), 94-501(WUC), 94-502(WUC), 94-503(WUC),
94-504(WUC), 94-505(DIS), 94-506(WUC), 94-507(WUC), 94-508(WUC),
94-509(WUC), 94-510(WUC), 94-511(WUC), 94-512(WUC), 94-513(WUC),
94-583(WUC), 94-584(WUC), 94-585(WUC), 94-586(WUC), 94-587(WUC),
94-588(WUC), 94-589(WUC), 94-590(WUC), 94-591(WUC), 94-592(WUC),
94-596(WUC), 94-597(WUC), 94-598(WUC), 94-599(WUC), 94-601(WUC),
94-603(WUC), 94-604(WUC), 94-612(WUC),

Water Use Types:

Stock Water-Beneficial Use Amount: Unevaluated Group Total: 1367 Period of Use: 06/16 to 09/30

Comments: Emery Allotment

Place of Use Stock:

	North West				North East				South West				South East			
	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE
Sec 23 T 21S R 5E SLBM															X	

Use Totals:

Stock Water sole-supply total: Unevaluated ELUs for a group total of: 1367 ELUs

Water Right Details for 94-429

Utah Division of Water Rights

11/8/2018 9:06 AM

(WARNING: Water Rights makes NO claims as to the accuracy of this data.)

Water Right: 94-429 Application/Claim: Certificate:

Changes:

a36154 (Filed: 12/21/2009) Lapsed

Owners:

Name: USA Forest Service
Address: 324 - 25th Street
Ogden UT 84401

Interest: 100%

Remarks:

General:

Type of Right: Diligence Claim Source of Info.: Proposed Determination Status: Water User's Claim
Quantity of Water: 0.011 CFS

Source: Link Canyon Spring #2
County: Sevier
Common Description:
Proposed Det. Book: 94-1 Map: * Pub. Date:
Land Owned by Appl.: County Tax Id#:
Distribution System:

Dates:

Filing:
Filed: 08/07/1981 Priority: / /1879

Advertising:
Publication Began: Publication End: Newspaper:
Protest End Date: Protested: Not Protested Hearing Held:

Approval:
State Eng. Action: Action Date:
Recon. Req. Date: Recon. Req Action:

Certification:
Proof Due Date: Extension Filed Date:
Election or Proof: Election/Proof Date:
Certificate Date: 08/07/1981 Lapsed, Etc. Date: Lapsed Letter

Wells:
Prov. Well Date: Well Renov. Date:

Points of Diversion:

Points of Spring:

(1) N 180 ft. E 680 ft. from SW corner, Sec 23 T 21S R 5E SLBM
Diverting Works: Source:
Elevation: UTM: 471167.652, 4313339.964

Water Uses:

Water Uses - Group Number: 618240

Water Rights Appurtenant to the following use(s):

94-417(WUC), 94-418(WUC), 94-419(WUC), 94-420(WUC), 94-421(WUC),
94-422(WUC), 94-423(WUC), 94-424(WUC), 94-426(WUC), 94-427(WUC),
94-428(WUC), 94-429(WUC), 94-430(WUC), 94-431(WUC), 94-432(WUC),
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94-499(WUC), 94-500(WUC), 94-501(WUC), 94-502(WUC), 94-503(WUC),
94-504(WUC), 94-505(DIS), 94-506(WUC), 94-507(WUC), 94-508(WUC),
94-509(WUC), 94-510(WUC), 94-511(WUC), 94-512(WUC), 94-513(WUC),
94-583(WUC), 94-584(WUC), 94-585(WUC), 94-586(WUC), 94-587(WUC),
94-588(WUC), 94-589(WUC), 94-590(WUC), 94-591(WUC), 94-592(WUC),
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94-603(WUC), 94-604(WUC), 94-612(WUC),

Water Use Types:

Stock Water-Beneficial Use Amount: Unevaluated Group Total: 1367 Period of Use: 06/16 to 09/30

Comments: Emery Allotment

Place of Use Stock:

	North West				North East				South West				South East			
	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE
Sec 23 T 21S R 5E SLBM											X					

Use Totals:

Stock Water sole-supply total: Unevaluated ELUs for a group total of: 1367 ELUs

Water Right Details for 94-591

Utah Division of Water Rights

11/8/2018 9:06 AM

(WARNING: Water Rights makes NO claims as to the accuracy of this data.)

Water Right: 94-591 Application/Claim: Certificate:

Changes:

a36154 (Filed: 12/21/2009) Lapsed

Owners:

Name: USA Forest Service
Address: 324 - 25th Street
Ogden UT 84401

Interest: 100%

Remarks:

General:

Type of Right: Diligence Claim Source of Info.: Proposed Determination Status: Water User's Claim
Quantity of Water: 0.011 CFS

Source: Link Canyon Spring
County: Sevier
Common Description:
Proposed Det. Book: 94-1 Map: * Pub. Date:
Land Owned by Appl.: County Tax Id#:
Distribution System:

Dates:

Filing:
Filed: Priority: / /1879

Advertising:
Publication Began: Publication End: Newspaper:
Protest End Date: Protested: Not Protested Hearing Held:

Approval:
State Eng. Action: Action Date:
Recon. Req. Date: Recon. Req Action:

Certification:
Proof Due Date: Extension Filed Date:
Election or Proof: Election/Proof Date:
Certificate Date: 08/07/1981 Lapsed, Etc. Date: Lapsed Letter

Wells:
Prov. Well Date: Well Renov. Date:

Points of Diversion:

Points of Spring:

(1) N 1800 ft. W 700 ft. from SE corner, Sec 23 T 21S R 5E SLBM
Diverting Works: Source:
Elevation: UTM: 472357.131, 4313827.772

Water Uses:

Water Uses - Group Number: 618240

Water Rights Appurtenant to the following use(s):

94-417(WUC), 94-418(WUC), 94-419(WUC), 94-420(WUC), 94-421(WUC),
94-422(WUC), 94-423(WUC), 94-424(WUC), 94-426(WUC), 94-427(WUC),
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94-504(WUC), 94-505(DIS), 94-506(WUC), 94-507(WUC), 94-508(WUC),
94-509(WUC), 94-510(WUC), 94-511(WUC), 94-512(WUC), 94-513(WUC),
94-583(WUC), 94-584(WUC), 94-585(WUC), 94-586(WUC), 94-587(WUC),
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94-596(WUC), 94-597(WUC), 94-598(WUC), 94-599(WUC), 94-601(WUC),
94-603(WUC), 94-604(WUC), 94-612(WUC),

Water Use Types:

Stock Water-Beneficial Use Amount: Unevaluated Group Total: 1367 Period of Use: 06/16 to 09/30

Comments: Emery Allotment

Water Uses - Group Number: 618250

Water Rights Appurtenant to the following use(s):

94-342(WUC), 94-514(WUC), 94-515(WUC), 94-516(WUC), 94-517(WUC),
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94-583(WUC), 94-584(WUC), 94-585(WUC), 94-586(WUC), 94-587(WUC),

Water Uses - Group Number: 618250

Water Rights Appurtenant to the following use(s):

94-588(WUC), 94-589(WUC), 94-590(WUC), 94-591(WUC), 94-592(WUC), 94-593(WUC), 94-594(WUC), 94-595(WUC), 94-596(WUC), 94-597(WUC), 94-598(WUC), 94-599(WUC), 94-600(WUC),

Water Use Types:

Stock Water-Beneficial Use Amount: Unevaluated Group Total: 238 Period of Use: 07/06 to 09/15

Comments: Blue Lake Allotment

Place of Use Stock:

	North West				North East				South West				South East			
	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE	NW	NE	SW	SE
Sec 26 T 21S R 5E SLBM														X		

Use Totals:

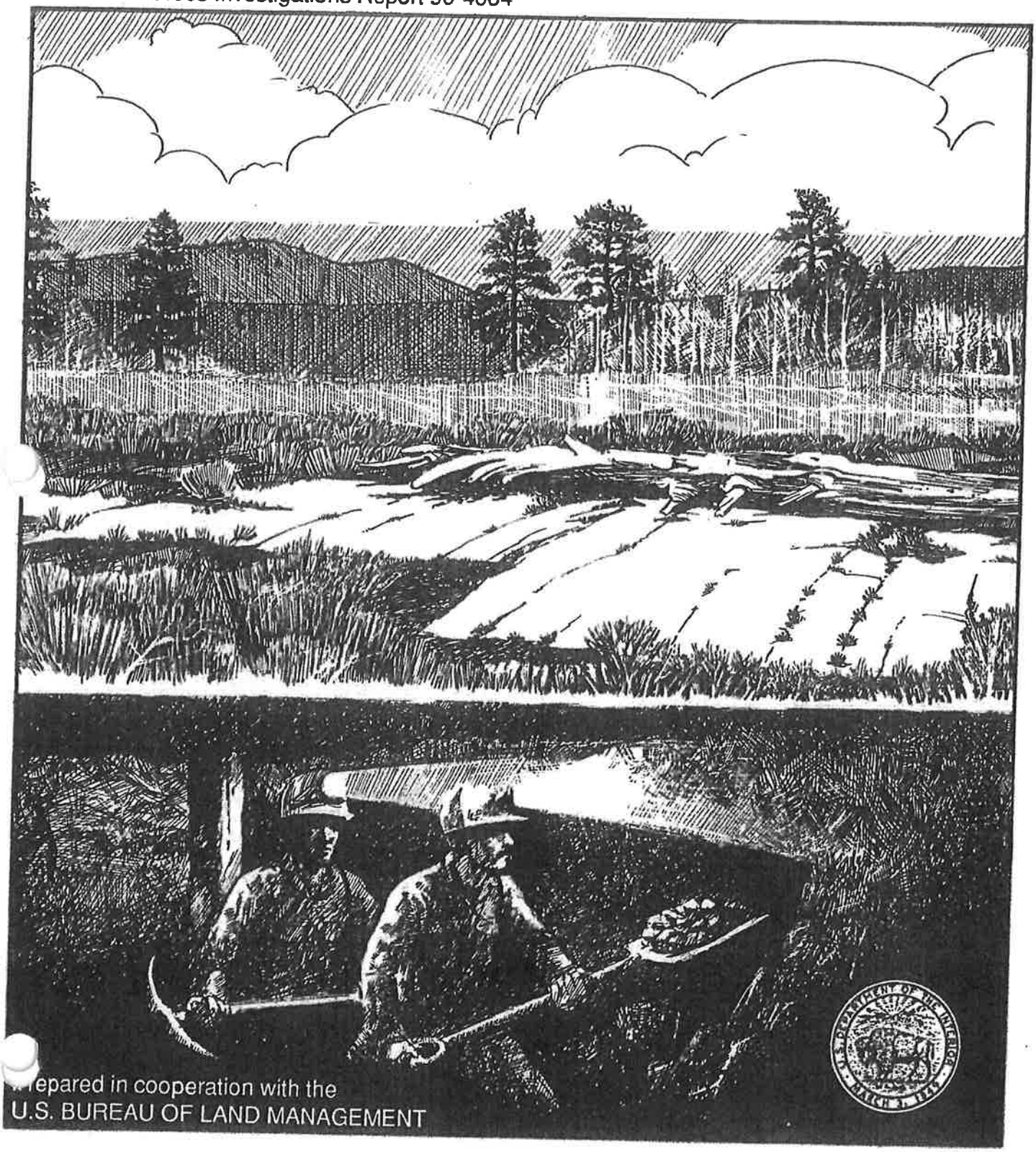
Stock Water sole-supply total: Unevaluated ELUs for a group total of: 1605 ELUs

APPENDIX 7-4

Water Quality Data Summaries

HYDROLOGY AND EFFECTS OF MINING IN THE QUITCHUPAH AND PINES COAL-LEASE TRACTS, CENTRAL UTAH

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 90-4084



Prepared in cooperation with the
U.S. BUREAU OF LAND MANAGEMENT

HYDROLOGY AND POTENTIAL EFFECTS OF MINING IN THE QUITCHUPAH AND PINES COAL-LEASE TRACTS, CENTRAL UTAH

By S.A. Thiros and G.E. Cordy

U.S. GEOLOGICAL SURVEY

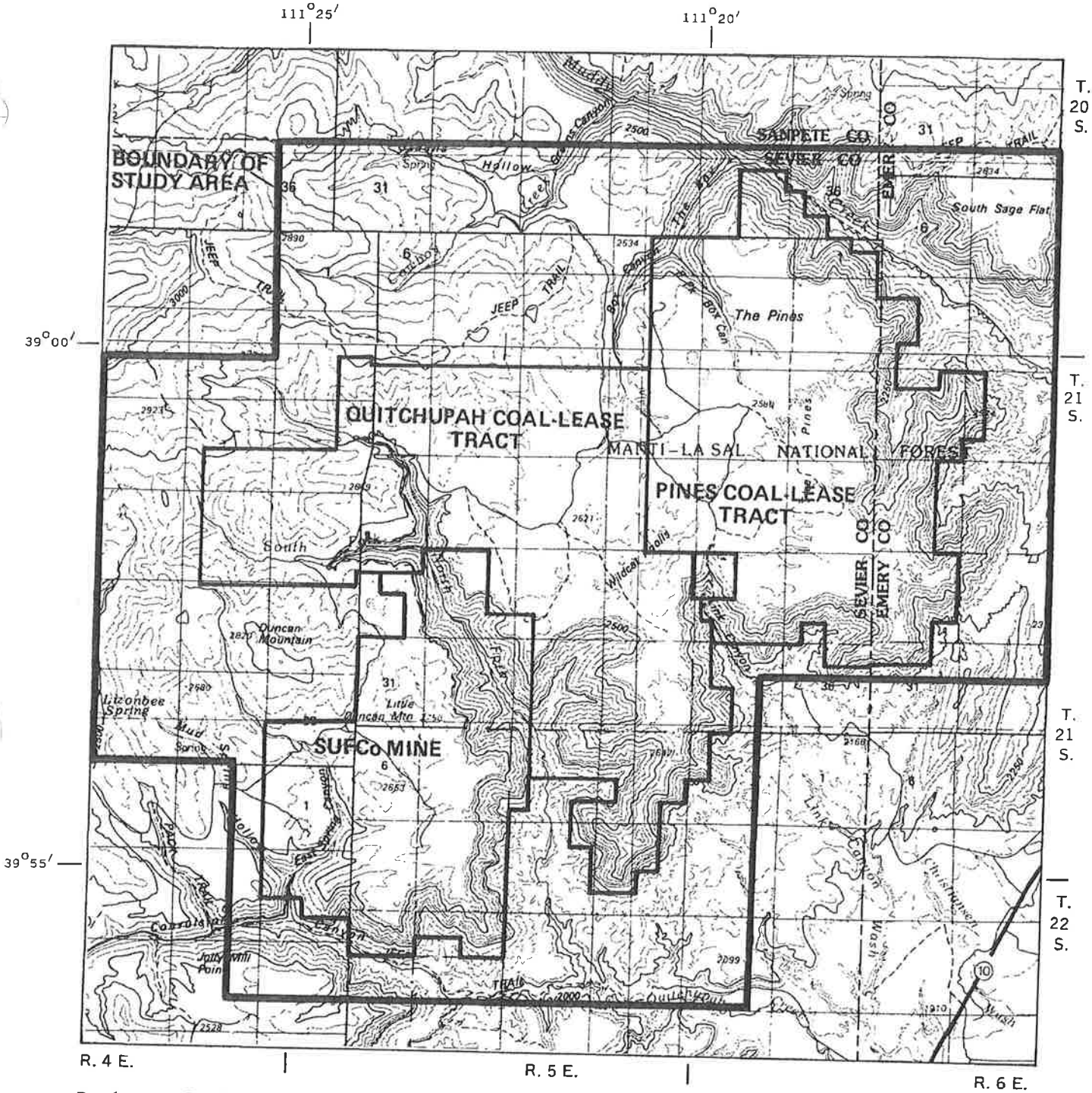
Water-Resources Investigations Report 90-4084

Prepared in cooperation with the

U.S. BUREAU OF LAND MANAGEMENT

Salt Lake City, Utah

1991



Base from U.S. Geological Survey 1:100,000 quadrangles, Salina, 1980 and Manti, 1981

0 1 2 3 MILES
0 1 2 3 KILOMETERS

CONTOUR INTERVAL 50 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 2.--Location of the Quitchupah and Pines coal-lease tracts, the tract containing the Southern Utah Fuel Co. (SUFCo) mine, and the boundary of the study area.

SUMMARY AND CONCLUSIONS

The Quitchupah and Pines coal-lease tracts, located in the Wasatch Plateau coal field of central Utah, include a total of about 30 square miles. Hydrologic data were collected from these tracts and the surrounding area in order to describe the hydrology and determine the potential effects of underground coal mining on the hydrologic system. The upper Hiawatha coal seam of the Cretaceous Blackhawk Formation currently is (1987) being mined in an area adjacent to the Quitchupah coal-lease tract by the Southern Utah Fuel Company.

Streams in the area drain to either Quitchupah or Muddy Creeks. Peak streamflow generally occurs in the spring due to snowmelt, although large flows can occur in the late summer and fall in response to thunderstorms.

The specific conductance of surface water in the study area decreases as streamflow increases because of dilution from runoff. Prior to the water's flowing across the lower part of the Blackhawk Formation, calcium, magnesium, and bicarbonate plus carbonate are the predominant ions. Surface water that has flowed across the Blackhawk Formation, Star Point Sandstone, and part of the Mancos Shale shows an increase in sulfate concentration.

Suspended-sediment concentrations are generally related to stream discharge. Although the largest concentration was measured on North Fork Quitchupah Creek during spring runoff, the largest suspended-sediment concentrations are usually the result of runoff from intense thunderstorms.

Parts of the Blackhawk Formation and the Star Point Sandstone are saturated in most of the study area. Water levels in several observation wells completed in the upper Hiawatha coal seam of the Blackhawk Formation are artesian (above the top of the perforated zone). The Blackhawk Formation and Star Point Sandstone are not saturated near the edge of the plateau, near canyons, and near the SUFCo mine where they are being dewatered.

Recharge to the saturated zones is principally by snowmelt seeping into outcrops. The annual recharge to the Castlegate Sandstone and the Price River Formation is estimated to be only about 1.2 percent of the annual normal precipitation. Water movement is controlled mainly by fractures, dip of the beds, and hydraulic conductivity of the materials. Most springs inventoried discharge near formation contacts and all of the springs found discharging from the Castlegate Sandstone were located on the east side of canyons, downdip from recharge areas.

Concentrations of dissolved solids in ground water sampled from springs and mines in the area ranged from 61 mg/L for water issuing near the top of the Castlegate Sandstone to 1,080 mg/L for water issuing from alluvium near the base of the North Horn Formation. Solubility indices indicate that water from most formations in the study area is undersaturated with respect to gypsum, anhydrite, and magnesite. The Flagstaff Limestone, North Horn Formation, and Price River Formation are supersaturated with respect to calcite and dolomite.

Water discharged from the SUFCo mine portal shows a greater concentration of sulfate than ground water discharging from the mine roof.

Tritium concentrations indicate that water discharging from a fault in the SUFCo mine must have entered the ground-water system at least 70 years ago while some of the water discharging from a spring at the base of the Castlegate Sandstone must have been recharged to the ground-water system sometime after 1952.

Observed effects of underground coal mining at the nearby Southern Utah Fuel Company mine are considered indicative of the changes that can be expected in the Quitchupah and Pines coal-lease tracts. Subsidence above the mined area could cause dewatering of the Blackhawk Formation and Star Point Sandstone, changes in the natural drainage patterns, and alteration of both surface- and ground-water quality. Additional studies are needed to gain a better understanding of the hydrologic effects of underground mining in the Quitchupah and Pines coal-lease tracts.

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APPENDIX 7-18

Investigation of Surface and Groundwater Systems in the Pines Tract Area, Sevier County, Utah: Probable Hydrologic Consequences of Coal Mining in the Pines Tract and Recommendations for Surface and Groundwater Monitoring

Probable Hydrologic Consequences of Mining in the 960-Acre Pines IBC Area, SUFCO Mine

Canyon Fuel Company, LLC, Salina, Utah

23 February 1999

Mayo and Associates, LC
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Introduction

This document describes the probable hydrologic consequences (PHC) of underground coal mining in the 960-acre Pines Incidental Boundary Change (IBC) area (Figure 1). The determination of the PHC is required by part R645-301-728 of the State of Utah Coal Mining Rules.

Potential Impacts to Surface Water and Groundwater

Potential impacts of coal mining on the quality and quantity of surface water and groundwater flow in the 960-acre IBC may include:

- Contamination from acid- or toxic-forming materials;
- Increased sediment yield from disturbed areas;
- Increased total dissolved solids concentrations;
- Flooding or stream flow alteration;
- Impacts to groundwater or surface water availability;
- Hydrocarbon contamination from above ground storage tanks or from the use of hydrocarbons in the permit area;
- Contamination of surface water and groundwater from road salting; and
- Contamination of surface water from coal spillage due to hauling operations;

These potential impacts are addressed in the following sections of this document.

Baseline Hydrologic and Geologic Information

Baseline geologic information is presented in Chapter 6 of the M&RP. Baseline hydrologic information for springs and streams in the vicinity of the 960-acre IBC area is presented in Table 1. The solute chemical compositions of springs and wells are plotted as Stiff diagrams in Figure 1. The isotopic compositions and calculated groundwater radiocarbon ages of groundwaters and surface waters in the vicinity of the 960-acre IBC area are presented in Table 2. The baseline monitoring data are believed to be representative of existing groundwater and surface water resources in the 960-acre IBC area.

PHC Determination

Potential adverse impacts to the hydrologic balance

Potential impacts to the hydrologic balance in the 960-acre IBC area are addressed in the following subsections of this document.

Presence of acid-forming or toxic-forming materials

Information on acid- and toxic-forming materials is presented in Chapter 6 of the M&RP. These data reveal boron, sodium absorption ratio, and specific conductance exceedances of the Table 2 guidelines for management of topsoil and overburden (Leatherwood and Duce, 1988) in waste rock from the SUFCO Mine. Acid-forming materials in western coal mines generally consist of sulfide minerals, which, when exposed to air and water, are oxidized causing the production of H^+ ions (acid). The sulfide mineral pyrite (FeS_2) has been identified in the SUFCO mine. Although the oxidation of pyrite occurs in the mine, acidic waters are not observed in the mine. The acid is quickly consumed by dissolution of

abundant, naturally occurring carbonate minerals. As noted in Section 7.2.4.2 of the M&RP, the alkalinity of mine discharge water typically exceeds the acidity of this water by a factor of 20. Iron is readily precipitated as iron-hydroxide and excess iron is not observed in the mine discharge water. Mine discharge water typically meets the standards for water quality for the State of Utah (Utah Water Quality Board, 1987).

No other acid-forming materials or any toxic-forming materials have been identified or are suspected to exist in materials disturbed by mining in the 960-acre IBC area.

Impact of coal mining on sediment yield from disturbed areas

The potential impact of mining and reclamation on sediment yield is an increase in the sediment load in surface waters downstream from disturbed areas. No surface facilities or disturbances are planned within the 960-acre IBC. Locally, sediment yields may temporarily increase where subsidence fractures intersect steep ephemeral drainages. However, most of the land surface in the IBC area is of relatively low relief and stream gradients are low. No land subsidence in the vicinity of the East Fork of Box Canyon or any of its tributaries will occur, thus, no increase in sediment yield in Box Canyon Creek is anticipated. Additionally, any increase in sediment yield in ephemeral drainages would be short lived, because sediment carried in the stream would quickly fill the subsidence fracture, and pre-subsidence conditions would be reestablished in the drainage. There are no major ephemeral drainages on the steep northern flanks of Wildcat Knolls within the IBC area.

No increase in the sediment load of mine discharge water above current levels is anticipated as a result of underground mining in the 960-acre IBC area.

Impacts to important water quality parameters

Solute and trace element compositions and field parameters of springs and creeks on the 960-acre IBC area have been monitored regularly since 1997 to determine baseline water quality. The results of these analyses are listed in Table 1. All of the groundwaters and surface waters monitored in the vicinity of the IBC area are of good quality.

There is no reason to suspect the quality of groundwater which will be intercepted during mining operations in the IBC will be significantly different than that encountered elsewhere in the SUFCO Mine. Thus, the potential for degradation of the receiving water for the SUFCO Mine discharge above current levels as a result of mining in the IBC area is minimal. The impacts to important water quality parameters in Quitchupah Creek (the mine discharge receiving water) as a result of mining in the SUFCO Mine are described in Section 7.2.8.3 of the SUFCO M&RP.

Inspection of the field parameters and solute and trace element compositions of springs in the existing SUFCO permit area (Mayo and Associates, 1997a) indicates no mining-related impacts on spring water quality. Indeed, it is difficult to envision a mechanism to significantly affect the water quality of springs in horizons above the mine. Similarly, water quality in creeks (excluding those receiving mine discharge water) has not been impacted. Because the conditions in the 960-acre IBC area are similar to those in the existing SUFCO

permit area, it is likely that there will be no degradation in the water quality of groundwaters and surface waters in the area as a result of mining in the 960-acre IBC area.

Flooding or streamflow alteration

Because there are no surface facilities, surface disturbances, or mine water discharges planned for the IBC area, there should be no significant changes to the flooding or streamflow alteration potential of streams in the area.

Generally, it is possible that mining-induced subsidence fractures occurring in areas near springs can alter groundwater recharge and discharge mechanisms, which in turn can impact streamflows. These impacts, which have been described in detail in several hydrologic investigations (USFS, 1999; Mayo and Associates, 1993, 1997a, 1997b), can result in either increases or decreases to spring and stream discharges. However, because there is only one spring (SUFCO 089) which discharges in the 960-acre IBC area, and this spring has been designated for protection by the USFS and will not be subsided, these impacts will likely not occur in the 960-acre IBC area.

Groundwater and surface water availability

Mining in the 960-acre Pines IBC area will not significantly affect the availability of groundwater. Previous hydrogeologic investigations (USFS, 1999; Thiros and Cordy, 1991; Mayo and Associates, 1993, 1997a, 1997b) have shown that groundwaters in the lower Blackhawk Formation exist in highly compartmentalized partitions, both vertically and horizontally, and that the formation does not act as a hydraulically continuous aquifer.

Groundwater systems in the Blackhawk Formation were also demonstrated to be hydraulically isolated from overlying, modern groundwaters. Groundwaters encountered in the SUFCO mine recharged many thousands of years ago (Table 2) and are not related to overlying shallow groundwater systems from which most springs discharge. The effects of locally dewatering the Blackhawk Formation adjacent to mine openings will not have any significant impact on groundwater availability in the region surrounding the IBC area.

There are no groundwater supply wells in the 960-acre Pines IBC or surrounding area. The removal of water from horizons immediately above and below the mined horizon will not impact any water supplies. Rather, underground mining makes water available from the Blackhawk Formation that was previously inaccessible.

Several springs are located in the regions immediately west and east of the 960-acre Pines IBC area. These springs are important because they provide baseflow to Box Canyon Creek and the East Fork of Box Canyon Creek and sustain local ecosystems. For several reasons, which are discussed later in this text, the potential to impact the quantity of discharge from springs surrounding the IBC area is believed to be minimal.

Two general types of springs occur in the Pines Tract and adjacent area. These include 1) shallowly circulating, fracture controlled springs, and 2) springs flowing through sandstone channels in the Blackhawk Formation deeper beneath the upland plateau. These two spring types and the potential mining-related impacts to each type are discussed below.

Shallowly circulating fracture controlled springs

Geologic, geochemical and isotopic evidence suggests that most of the springs that occur in the vicinity of the Pines IBC area discharge from shallowly circulating groundwater systems in the Castlegate Sandstone and upper Blackhawk Formation which recharge near the canyon escarpments (USFS, 1999; Mayo and Associates, 1997b). These springs discharge modern groundwater and are highly responsive to seasonal variations in recharge. Recharge to the groundwater systems supporting the springs occurs within approximately 1,000 feet of the escarpment, where naturally occurring fractures dilate due to removal of confining pressure on the rocks (USFS, 1999). Unfractured Castlegate Sandstone is relatively impermeable because of the pervasiveness of cementing in the intergranular spaces. Further away from the escarpment, fracture apertures are very small and the ability of the rocks to transmit water is minimal. Groundwater is generally unable to migrate downward deeper into the rock section because of the pervasiveness of shale and mudstone layers in the upper Blackhawk Formation. Thus, the lateral distance from the recharge area to the spring is less than about 1,000 feet. The springs surrounding the IBC area are located at distances which are greater than approximately 1,000 feet from the closest planned longwall mining in the IBC area. Therefore, no detrimental impacts to these springs are anticipated as a result of mining in the IBC. An exception to this will occur at spring SUFCO 089, which is located within the 960-acre Pines IBC area. However, this spring has been designated for protection by the USFS and should not be impacted (USFS, 1999). Additionally, all of the springs immediately adjacent to the IBC area discharge where the overburden thickness is greater than 720 feet, suggesting that these springs will likely not be affected by mining (USFS, 1999).

Deeply circulating sandstone paleochannel springs

A few springs in the vicinity of the Pines IBC area discharge from groundwater systems which flow more deeply beneath the plateau. Examples of these springs area include Pines 206 and Pines 204. These springs discharge water which is up to several thousand years old and do not exhibit significant seasonal variations in discharge rates. According the USFS (1999), these springs likely flow horizontally down-dip through permeable sandstone paleochannels in the Blackhawk Formation from recharge areas near the cliff faces along the eastern edges of the Pines Tract to the discharge locations near the bottom of Box Canyon. Because the sandstone channels are commonly three-dimensionally encased in low permeability shales and mudstones, the flowpaths of these groundwater systems are constrained by the geometry of the paleochannels in which they flow. Thus, the groundwater flowpath is more or less horizontal and controlled by the stratigraphic dip of the Blackhawk Formation. Longwall mining will occur beneath the sandstone channels which support the sandstone channel springs. Based on this model, it is possible to calculate the stratigraphic separation between the bottom of the groundwater system which supports individual springs and the top of the interval to be mined. These calculations (including those for the shallowly circulating fracture controlled springs) are listed in Table 3. Using the commonly accepted estimate that the height to which subsidence fractures propagate upward from longwall mined areas equals approximately 30 times the extraction height (approximately 10 feet in the IBC area), an estimate of 300 feet is predicted (Kadnuk, 1994). Thus, because all of the groundwater systems from which the deeply circulating sandstone paleochannel springs discharge are separated from the mined horizon by more than 400 feet, detrimental impacts to these springs are not anticipated. A minimum 60 times mining height (600 feet) overburden

thickness is suggested by the Society of Mining Engineers, which would represent a 300 foot (two-times) safety factor. The likely recharge locations for the sandstone paleochannel springs lie in undisturbed areas well beyond the IBC boundary.

Stock watering ponds

Previous experience has shown that some stock watering ponds in the region have been impacted by surface fracturing when they have been undermined with longwall mining, while others have not (USFS, 1999). It is not unlikely that Pines 409 (Slab Pond) and Pines 410 (Verdes Pond) will be adversely impacted in their ability to hold water as a result of cracking of the substrate of the pond. These ponds are fed by surface water runoff in ephemeral drainages and are not fed by springs, and, thus, the volume of water available to fill the ponds should not change as a result of mining in the IBC area. It is possible that some of the water flowing in the ephemeral drainages could be rerouted downward into subsidence fractures before it reaches the ponds. However, these impacts should be short-lived because sediments will eventually fill the subsidence fractures and the water pathways should be restored to essentially pre-mining conditions. As a result of variable subsidence at the surface on the relatively flat plateau, subtle changes to surface water drainages can occur. As a result, surface waters may be diverted some small distance away from stock watering ponds.

Potential Hydrocarbon Contamination

Diesel fuels, oils, greases, and other hydrocarbon products are stored and used at the SUFCO Mine site for a variety of purposes. However, none of these products will be stored in the 960-acre IBC area, and only minimal use of these products in the IBC area will occur. These

uses will be limited primarily to the fuel and oils used in vehicles during surface activities such as hydrologic and subsidence monitoring, and the transportation of water in trucks. The potential for spills of hydrocarbons under these circumstances is remote. Additionally, a Spill Prevention Control and Countermeasure Plan has been implemented which will help minimize any potential detrimental impacts to the environment (SUFCO M&RP, Appendix 7-6).

Road Salting

No salting of the roads within the 960-acre IBC occurs. This potential impact is not a significant concern.

Coal Haulage

Mining in the 960-acre IBC area should not result in increased contamination of surface waters from coal spillage due to hauling operations above current levels. This impact is not a significant concern. The environmental impacts resulting from coal haulage at the SUFCO Mine are described in Section 7.2.8 of the SUFCO M&RP.

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Table 2 Groundwater isotopic compositions and calculated mean residence times

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Site	Date	$\delta^{13}C$ ‰	^{14}C pmc	^{3}H TU	Overburden feet	Mean Residence Time years
Current SUFCO Lease Area						
Creeks						
007	10/3/95			15.6		
North Horn Formation Springs						
057A	10/3/95	-15.8	109.5	13.0		modern
GW-13	10/3/95	-11.1	80.89	8.64		modern
GW-13	6/10/96			8.57		modern
Upper Blackhawk Formation Springs						
001	10/3/95	-12.4	90.7	18.8		modern
Lower Blackhawk (In-Mine roof-drips)						
R01	4/12/93	-10.1				
R02	4/12/93	-5.7	7.2	<3.0	1000	
R03	4/12/93	-7.5				
R04	9/20/96	-7.7		0.00	800	
R05	4/12/93	-12.1		0.52	500	
R06	4/12/93	-6.6				
R07	4/12/93	-9.9				
R08	4/12/93	-11.6		1.10	1200	
R09	4/12/93	-9.6				
R11	4/12/93	-10.1				
R12	4/12/93	-7.7		1.10	1000	
R12	4/11/96			0.24	1000	
R13	4/12/93	-11.2				
R14	4/11/96	-8.9	12.34		1000	12,000
R15	4/11/96	-8.9	8.91		1200	15,000
R16	4/11/96	-8.2	5.31	0.00	800	19,500
R17	4/11/96	-8.7	9.51	0.00	1000	14,500
1L 6E Seal	10/28/96	-7.7	11.51	0.17		13,000
12L 4E test hole	9/18/97	-11.2	21.07	0.00	1000	7,500
12L 4E fault	9/18/97	-7.1	20.38	0.10	1000	7,500
Star Point Sandstone Springs						
047	10/4/95	-12.3	25.27	0.23		7,300
047	6/10/96			0.10		
047A	10/2/95			0.77		
047A	6/10/96			0.78		
Pines Tract Sites						
Creeks						
Pines 106	11/3/97			6.01		
Pines 403	10/22/97			4.16		
Castlegate Sandstone Springs						
GW-21	10/3/95	-12.4	105	5.67		modern
GW-21	6/10/96			5.63		modern
Pines 100	6/28/97	-14.1	103.51	5.15		modern
Pines 105	6/28/97	-15.6	92.55	6.48		modern
Pines 105	11/3/97			5.89		
Pines 310	11/3/97	-14.0	108.69	16.4		modern
Blackhawk Formation Springs						
Pines 204	6/27/97	-9.5	49.90	0.74		500
Pines 206	6/27/97			0.69		
Pines 206	10/29/97	-10.9	38.40	0.52		3,000
Pines 214	6/27/97	-10.1	62.32	8.55		modern
Pines 214	11/3/97			4.62		
Pines 301	6/27/97			16.1		
Pines 303	6/27/97	-9.9	30.27	0.20		4,000
Pines 303	10/29/97	-9.5	32.57	0.08		3,500

Table 3 Stratigraphic separation between spring discharge locations and the top of the coal seam to be mined.

Spring elevations relative to hiawatha.xls 23 Feb 99

Spring	Spring elevation	Elevation of coal seam below spring	Feet above the top of Hiawatha coal seem
Pines 307	7700	7373	327
Pines 205	7740	7363	377
Pines 204	7800	7355	445
Pines 208	8000	7370	630
Pines 206	8000	7368	632
Pines 207	8040	7375	665
Pines 213	8120	7448	672
Pines 214	8160	7466	694
Pines 215	8180	7473	707
Pines 203	8080	7360	720
Pines 209	8080	7360	720
Pines 216	8210	7476	734
Pines 216A	8210	7476	734
Pines 202	8100	7365	735
Pines 210	8100	7360	740
Pines 201	8120	7365	755
Pines 217	8250	7485	765
Pines 217A	8250	7485	765
Pines 211	8140	7365	775
Pines 212	8140	7365	775
Pines 218	8190	7390	800
Pines 219	8210	7400	810
SUFCO 089	8320	7492	828
GW-21	8480	7641	839
Pines 100	8480	7638	842
Pines 103	8380	7530	850
Pines 101	8600	7685	915
Pines 102	8560	7628	932

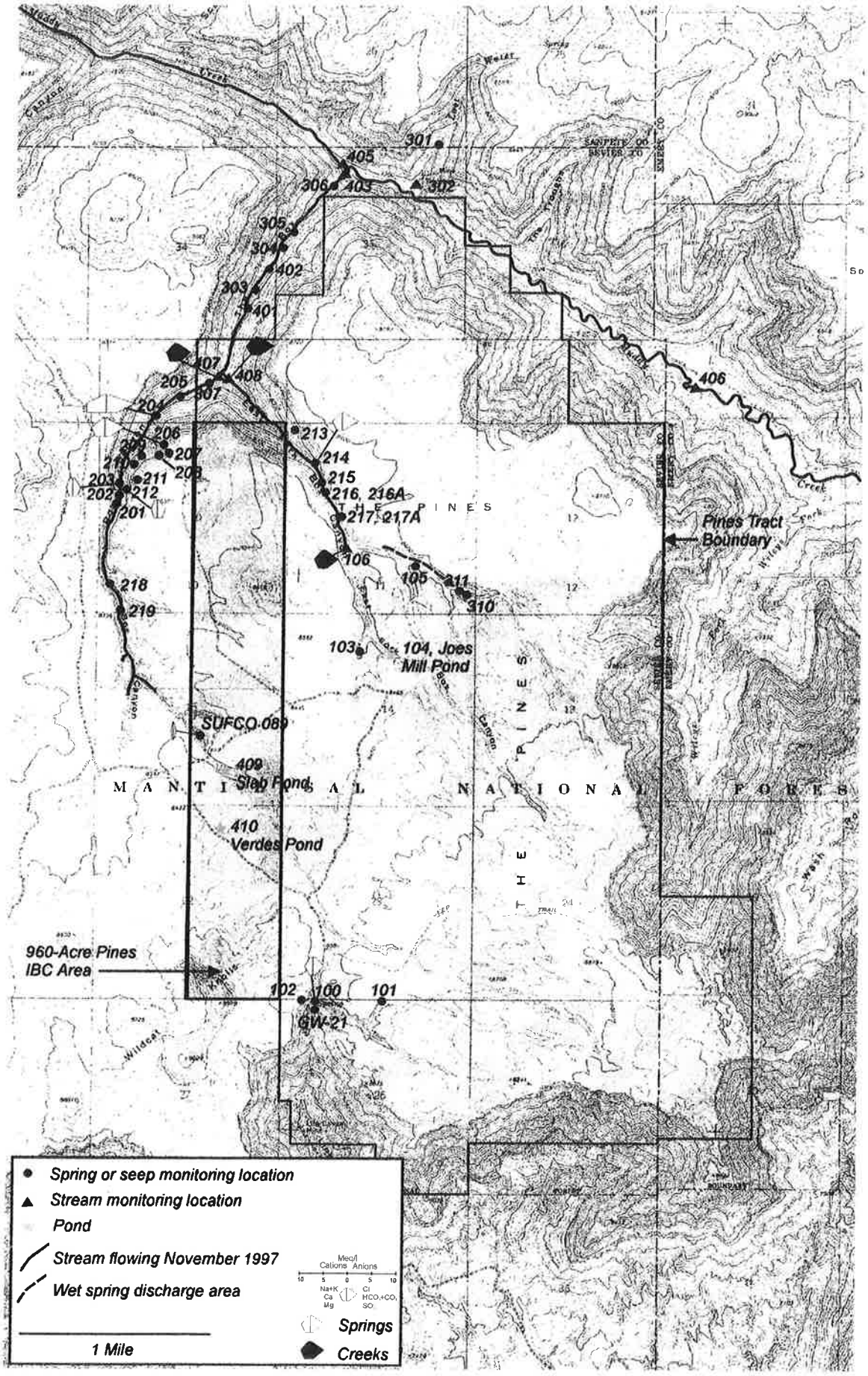

Figure 1 Location of 960-Acre Pines IBC Area, with spring and creek locations and selected stiff diagrams.

Table 1 Baseline discharge and water quality data from the Pines Tract

pines_baseline xls 23 Feb 99

Site	Date	Flow gpm	T °C	pH	Cond µS/cm	TDS mg/l	TSS mg/l	Turb NTU	DO mg/l	O&G mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO_3 mg/l	CO_3 mg/l	SO_4 mg/l	Cl mg/l	B mg/l	NO_3 NO_2 mg/l	PO_4 mg/l	Fe(t) mg/l	Fe(c) mg/l	Mn(t) mg/l	Mn(d) mg/l	Se mg/l	As(d) mg/l	As(t) mg/l	Cd(d) mg/l	Cd(t) mg/l	Pb(d) mg/l	Pb(t) mg/l	Hg(d) ug/l	Hg(t) mg/l	Mo(t) mg/l	Zn(t) mg/l
SPRINGS																																				
Pines 100	03-Jun-97	0.13	16.6	7.7	372	210					35	8	15	3	144	<5	29	17	<0.1	<0.1	0.05	<0.1	<0.1	<0.1	<0.1	<0.01											
Pines 100	28-Jun-97			7.3		210					43	11	16	2	131	<5	23	16	0.1	<0.1	0.07	0.5	0.2	0.1	<0.1												
Pines 100	28-Aug-97	1.4	11.5	7.45	396	180		0.8			35	8	14		140	<5	17	16	<0.1	0.2	0.02	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 100	29-Oct-97	2.5	4.4	7.3	241	190	<5	0.7			32	6	14	1	189	<5	29	16	0.2	<0.1	0.03	8.3	<0.1	0.2	<0.1	<0.01		<0.01		<0.01	<0.1	<0.1		<0.2	<0.1	0.09
Pines 100	16-Sep-98	0.83	12.5	7.8	280	211		0.9			34	8	14	1	138	<5	22	18	0.2	<0.1		0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 100	29-Jun-98	0.61	12.5	7.77	260	201		2.4			33	11	16	2	159	<5	27	22	0.2	<0.1		0.5		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 101	04-Jun-97	0.02	17.6	7.1	210	180					32	4	5	2	84	<5	<5	5	<0.1	<0.1	0.05	2.1	1.4	0.2	0.2	<0.01										
Pines 101	29-Oct-97	dry																																		
Pines 102	04-Jun-97	0.17	25.2	8.34	171	140					14	4	5	4	66	<5	5	8	<0.1	<0.1	0.22	1	0.4	<0.1	<0.1	<0.01										
Pines 102	29-Oct-97	dry																																		
Pines 103	04-Jun-97	0.18	17.6	7.2	137	90					9	1	4	1	38	<5	7	4	<0.1	0.3	0.02	0.7	0.2	<0.1	<0.1	<0.01										
Pines 103	03-Nov-97	<0.5	3.5	8.2	106																															
Pines 105	17-Jun-97	12	7	6.31	252	130					24	5	8	1	94	<5	5	9	<0.1	0.3	0.04	0.2	<0.1	<0.1	<0.1	<0.01										
Pines 105	28-Jun-97	10	5.2	7.1	202	140					25	5	8	1	87	<5	13	8	0.1	0.3	0.03	<0.1	<0.1	<0.1	<0.1	<0.1										
Pines 105	28 Aug-97	2.61	5.5	7.5	306	120		3			23	5	8		92	<5	10	9	<0.1	0.3	0.01	0.3	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 105	03-Nov-97	10	5.3	7.5	193	120	28	4.5			22	5	7	<1	88	<5	9	9	0.2	0.4	0.02	0.2	<0.1	<0.1	<0.1	<0.01		<0.01		<0.01	<0.1	<0.1		<0.2	<0.1	0.02
Pines 105	29-Jun-98	3	6.9	8.35	260	135		62.5			23	5	8	4	100	<5	11	11	0.1	<0.1		1.6		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 105	16-Sep-98	11.1	5.6	7.7	190	157		0.2			23	5	8	<1	98	<5	13	11	0.2	0.3		<0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 201	27-Jun-97	<1	7.4	7.4	150	120		0.7			26	7	8	1	87	<5	23	9	<0.1	0.3	0.02	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 202	27-Jun-97	<1	7.4	7.8	153																															
Pines 202	29-Oct-97	1	4.3	7.9	126																															
Pines 203	27-Jun-97	?	6.6	7.8	175																															
Pines 203	28-Aug-97	4	11	8	303	170		0.4			30	10	15		110	<5	53	13	0.1	0.5	<0.01	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 204	27-Jun-97	<1	8.3	7.7	518	450		5.9			89	34	13	1	389	<5	118	15	0.2	<0.1	0.02	0.3	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 205	27-Jun-97	<1	8.4	8	628																															
Pines 206	27-Jun-97	3	7.7	8.2	377	300		0.4			66	27	11	1	358	<5	53	14	<0.1	0.1	0.02	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 206	28-Aug-97	3.23	12	7.6	535	300		0.2			63	26	10		230	<5	100	13	0.1	0.5	<0.01	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 206	29-Oct-97	1.2	6.8	7.4	352	310	160	48			59	24	10	1	195	<5	52	14	0.2	0.1	0.01	0.4	<0.1	<0.1	<0.1	<0.01		<0.01		<0.01	<0.1	<0.1		<0.2	<0.1	0.03
pines 206	29-Jun-98	3.2	5.9	7.81	450	316		0.6			55	25	13	1	282	<5	56	18	0.2	<0.1		<0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 206	16-Sep-98	2.7	6.8	7.9	450	345		0.7			63	26	10	1	285	<5	52	14	0.2	<0.1	1	<0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 207	27-Jun-97	<1	7.7	8	310																															
Pines 207	29-Oct-97	2	2.7	8	258																															
Pines 208	27-Jun-97	6	5.9	7.9	244																															
Pines 209	27-Jun-97	<1	7.4	8.1	270																															
Pines 209	29-Oct-97	1	6.3	7.4	251																															
Pines 210	27-Jun-97	<1	11.4	7.8	340																															
Pines 210	29-Oct-97	dry																																		
Pines 211	27-Jun-97	<1	10.8	8	235																															
Pines 211	29-Oct-97	<0.1	6.7	7.6	159																															
Pines 211A	29-Oct-97	<0.1	7.1	7.5	282																															
Pines 212	27-Jun-97	1	7.9	7.5	213																															
Pines 212	29-Oct-97	4.5	5.1	7.8	191																															
Pines 212	29-Jun-98	3	6.9	6.35	260	164		0.4			28	11	15	2	104	<5	46	14	0.2	0.1		<2.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 212	16 Sep 98	4	7.5	8.5	220	218		0.7			29	9	15	1	114	<5	50	14	0.2	0.5		<2.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 213	27-Jun-97	<1	10.5	8	850																															
Pines 213	03 Nov-97	<0.1	4.7	8.1	212																															

Site	Date	Flow gpm	T °C	pH	Cond µS/cm	TDS mg/l	TSS mg/l	Turb NTU	DO mg/l	O&G mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	HCO_3 mg/l	CO_3 mg/l	SO_4 mg/l	Cl mg/l	B mg/l	NO_3 mg/l	PO_4 mg/l	Fe(t) mg/l	Fe(d) mg/l	Mn(t) mg/l	Mn(d) mg/l	Sb mg/l	As(d) mg/l	As(t) mg/l	Cd(d) mg/l	Cd(t) mg/l	Pb(d) mg/l	Pb(t) mg/l	Hg(d) ug/l	Hg(t) mg/l	Mo(t) mg/l	Zn(t) mg/l
Pines 214	27-Jun-97	2	7.4	8.8	390	230					40	13	7	1	188	<5	22	6	0.6	0.3	0.04	3.7	<0.1	0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 214	28-Aug-97	1.33	10	8.2	364	230		2.1			47	16	8		227	<5	14	3	<0.1	<0.1	0.01	0.3	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 214	03-Nov-97	1.7	0.5	8.1	206	210	13	1			44	15	7	<1	215	<5	17	8	0.2	<0.1	0.02	0.2	<0.1	<0.1	<0.1	<0.01		<0.01		<0.01	<0.1	<0.1		<0.2	<0.1	0.02
Pines 214	29-Jun-98	2	11.1	8.25	290	193		0.6			42	14	8	1	207	<5	17	10	0.2	<0.1		<0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 214	16-Sep-98	0.61	12.2	7.8	340	248		2.6			46	15	8	<1	215	<5	19	9	0.2	<0.1		<0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 215	27-Jun-97	<1	9	8	340																															
Pines 215	03-Nov-97	<0.5	1.6	8.1	248																															
Pines 216	27-Jun-97	<1	6.7	7.7	254																															
Pines 216	03 Nov 97	<1	2.3	8.4	190																															
Pines 216A	03 Nov-97	1	5.3	8.3	153	170	137	18			30	10	7	<1	141	<5	13	5	0.2	0.3	0.03	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01	<0.01	<0.1	<0.1		<0.2	<0.1	0.04
Pines 217	27-Jun-97	<1	12.4	7.8	334																															
Pines 217	03 Nov-97	<0.5	1.5	8	150																															
Pines 217A	03-Nov-97	<0.1	1.2	7.9	172																															
Pines 218	27-Jun-97	<1																																		
Pines 218	29-Oct-97	dry																																		
Pines 219	27-Jun-97	<1	8.8																																	
Pines 219	29-Oct-97	<0.1	3.3	8.2	85																															
Pines 301	27-Jun-97	<0.1	17	7.7	1175						81	66	88	4	556	<0.1	200	35		0.36																
Pines 301	22-Oct-97	<0.1	5.7	8.2							82.2	26	92.1	2.96	443		279	28.6		0.14																
Pines 303	27-Jun-97	2.6	9	8.5	275	240		2.9			49	19	5	1	222	<5	32	9	0.1	<0.1	0.02	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 303	27-Aug-97	3.16	9	8.2	387	220		1.3			49	19	6		217	<5	27	10	<0.1	<0.1	<0.01	0.2	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 303	29 Oct-97	3.2	7.6	8.4	410	240	<5	0.6			45	19	6	1	232	<5	29	15	0.2	<0.1	0.02	0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01	<0.01	<0.1	<0.1		<0.2	<0.1	0.01
Pines 303	30 Jun-98					218		1.4			45	19	6	1	221	<5	32	11	0.2	<0.1		1.3		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 303	16-Sep-98		8.6	8.1	350	272		5			49	18	5	1	222	<5	34	9	0.3	<0.1		2		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 304	27-Jun-97	<0.1	9.7	7.7	719																															
Pines 304	29 Oct-97	1	6.8	7.9	926																															
Pines 305	27-Jun-97	<0.1																																		
Pines 305	29 Oct-97	dry																																		
Pines 306	27-Jun-97	damp																																		
Pines 306	29 Oct-97	dry																																		
Pines 307	27-Jun-97	damp																																		
Pines 307	29 Oct 97	dry																																		
Pines 310	03-Nov 97	1.5	6.6	8.2	89	280	143	15			19	5	7	<1	78	<5	14	8	<0.1	0.2	0.02	0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01	<0.01	<0.1	<0.1		<0.2	<0.1	0.03
Pines 311	03-Nov-97	1	5.7	8	116																															
Pines 401	29-Oct-97	1	6		910																															
Pines 402	29-Oct-97	<1	7	7.5	857																															
GW-20	16-Sep-86	1.6	7.0	6.8	215	142					22	5.8	9.4	1.7	91		20	9.2						0.088		0.210										
GW-21	11-Aug-79		20.5	7.5	310						35	8.5	12	1.3	117		20	15						0.060		<0.01										
GW-21	11-Aug-79	0.2	7		260																															
GW-21	30 Jun-79	0.3	8		320																															
GW-21	30-Jun-80	0.4	5.5		290																															
GW-21	23 Jul-80	0.3	6		275																															
GW-21	05-Aug-80	0.2	6.5		250																															
GW-21	21 Aug 80	0.2	6		255																															
GW-21	11 Sep 80	0.2	6.5		275																															
GW-21	16-Sep-80	0.2	6		290																															
GW-21	29-Sep-80	0.3	6		300																															
GW-21	15-Jul-86	0.7	6.5		310																															
GW-21	04-Aug-86	0.6	7		295																															
GW-21	20-Aug-86	0.6	7		315																															

Site	Date	Flow	T		Cond	TDS	TSS	Turb	DO	O&G	Ca	Mg	Na	K	HCO_3	CO	SO_4	Cl	B	NO_2	PO_4	Fe(t)	Fe(d)	Mn(t)	Mn(d)	Se	As(d)	As(t)	Cd(d)	Cd(t)	Pb(d)	Pb(t)	Hg(d)	Hg(t)	Mo(d)	Zn(t)
		gpm	°C	pH	µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
GW 21	15-Sep-86	0.7	7.5		300																														
GW-21	04-Nov-86	0.9	5		300																														
GW 21	11-May-87	1.1	5		310																														
GW-21	16-Jun-87	0.9	5.5		310																														
GW-21	20-Jul-87	0.7	6.5		310																														
GW-21	08-Sep-87	0.6	7		310																														
SUFCO 089	27-Jul-89		14	7.2	97	104					12.32	2.54	2.28	2.94	54	0	5	2.7				0.54	0.19	0.001												
SUFCO 089	22-Aug-89		9	6.5	111	43					7.48	1.55	0.97	2.86	41	0	30	1.5				0.83	0.22	0.001												
SUFCO 089	18 Sep-89	1.29	7	6	125	85					11.22	2.61	2.24	2.28	28	0	18	2.4				0.19	0.04	0.001												
SUFCO 089	09-Oct-89	1.3	2	5.9	139	103					11.5	2.44	2.29	2.4	51	0	3	2.3				0.31	0.28	0.001												
SUFCO 089	23-May-90	1.17	4	7.2	64	50					8.36	1.94	1.85	1.47	51	0	6	1.9				0.37	0.03	0.002												
SUFCO 089	20-Aug-90	1.07	12	7.4	79	100					10.51	4.98	5.66	1.49	66	0	11.5	6.1				0.24	0.03	0.001												
SUFCO 089	15 Oct-90	0.98	2	6.8	107	82					10.84	2.33	4.44	2.8	58	0	33	2.3				0.79	0.4	0.1												
SUFCO 089	29-May 91	1.14	3.9	7.2	85	54					10.07	2.36	1.79	1.52	42	0	5	1.6				0.84	0.22	0.013												
SUFCO 089	27-Aug-91	0.88	11	7.06	89	56					9.91	2.83	2.27	1.3	31	0	4.2	2.8				0.34	0.033	0.003												
SUFCO 089	03 Oct-91	1.02	6.2	7.02	90	64					10.38	2.41	1.58	2.17	54	0	3.6	2.8				0.013	0.16	0.003												
SUFCO 089	12-May-92	1.13	6.5	7.71	54	32					8.16	1.36	0.9		35.2	0	4.3	2.2				0.22	0.19													
SUFCO 089	04-Aug-92	0.57	12.5	8.62	98	60						1.97	1.52	2.74	29	0	3	3.3				0.5	0.03													
SUFCO 089	06 Oct-92	0.66	5	7.29	202	93					7.7	2.5	2.12	2.46	26	0	6	9.2				0.75	0.13													
SUFCO 089	09-Jun-93	1.18	5	7.98	92	38					9.25	2.05	2.86	1.79	36.4	0	3.8	2.55				0.14	0.2													
SUFCO 089	11-Aug-93	0.95	11	7.9	106	36					8.73	2.39	2.57	1.66	33.2	0	4.8	4.72				0.24	0.2													
SUFCO 089	04 Oct-93	0.7	3	7.89	108	64					9.11	2.42	2.42	1.43	34.5	0	4.9	3.04				0.11	0.02													
SUFCO 089	07-Jun-94	1.11	9.1	8.09	141	38					7.99	1.61	2.02	1.1	33	0	6.1	0				0.14	0.01													
SUFCO 089	22 Aug 94	0.26	13	7.94	106	58					10	3	2	2	32	0	4	2				0.02	0.01													
SUFCO 089	05-Jun-95	1.18	10.7	7.52	96	100					7	2	3	2	30	0	0	2				0.1	0													
SUFCO 089	24 Aug 95	1.14	12	7.91	89	60					9	1	3	3	60	0	0	1				0.2	0.1													
SUFCO 089	03-Oct-95	1.1	5	7.6	126	30					9	2	1	3	45	0	0	3				0.7	0.3													
PONDS																																				
Pines 104	17-Jun-97		15	7.3	347	200					34	8	13	6	135	<5	21	14	<0.1	<0.1	0.03	0.6	0.3	<0.1	<0.1	<0.01											
Pines 104	29 Oct-97		1	7.2	222	256	10390	240			43	10	17	9	194	<5	12	20	0.4	<0.1	0.03	86	0.1	1.4	0.4	<0.01		<0.01		<0.01	<0.1	0.01		<0.2	<0.1	0.37
Pines 409	17-Jun-97	dry																																		
Pines 409	03 Nov 97	dry																																		
Pines 410	*7-Jun-97	nearly dry																																		
Pines 410	03-Nov-97	1 foot deep, 2 ponds 20 in diameter																																		
CREEKS																																				
Pines 106	18 Jun-97		8	7.5	411	200					44	14	9	1	177	<5	30	11	<0.1	<0.1	0.05	0.1	<0.1	<0.1	<0.1	<0.01											
Pines 106	28-Aug-97	25	18.5	7.9	381	220		3.4			46	16	9		192	<5	27	11	0.1	<0.1	0.02	0.3	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1					
Pines 106	03-Nov-97	1	6.3	7.6	420	260	19	4.5	6.3	<2	43	16	8	1	219	<5	39	11		0.1	0.02	1.4	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.01		<0.1		<0.2	<0.1	0.04
Pines 106	29-Jun-98		23.4	7.55	340	214	14	18	4.7	<2	40	13	9	4	186	<5	31	13	0.3	<0.1		0.9		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 106	16 Sep 98	2.2	20.3	7.4	380	274	10	3.3	6.1	<2	48	17	9	2	204	<5	40	13	0.2	<0.1			<0.1	<0.1		9	<0.01		<0.01		<0.1		<0.2			
Pines 107	18-Jun-97		12.2	8.8	432	200					47	21	5	<1	245	<5	19	3	<0.1	0.6	0.03	0.7	<0.1	<0.1	<0.1	<0.01											
Pines 107	03-Nov-97		4.1	8.3	445	260	538	165	7.7		43	24	11	1	269	<5	21	4		0.5	0.03	4.6	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2	<0.1	0.04	
Pines 302	26-Jun 97		17	8.5	300	260		30			34	28	34	2	247	18	22	6	<0.1	<0.1	0.02	0.5	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 302	27-Aug-97	dry																																		
Pines 302	22-Oct-97	15	4.3	8.49	648	380	28	14	5.6	<2	24	28	63	3	359	8	20	14	0.02	<0.1	<0.01	0.5	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2	<0.1	0.04	
Pines 403	27-Jun-97	40																																		
Pines 403	27-Aug-97	104	14.5	8.5	448	270		16		<2	50	22	10		246	<5	37	14	0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2			
Pines 403	22-Oct-97	81	2.3	8.25	519	280	<5	12	5	<2	54	27	11	1	259	<5	49	13	0.2	<0.1	0.01	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2	<0.1	0.03	

Site	Date	Flow	T	pH	Cond	TDS	TSS	Turb	DO	O&G	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl	B	NO_2	PO_4	Fe(t)	Fe(d)	Mn(t)	Mn(d)	Se	As(d)	As(t)	Cd(d)	Cd(t)	Pb(c)	Pb(t)	Hg(d)	Hg(t)	Mo(t)	Zn(t)
		gpm	°C		µS/cm	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Pines 403	30-Jun-98					343	217	0.7	6.7	<2	49	27	12	2	255	<5	65	21	0.2	<0.1		<0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 403	17-Dec-98		16	8.1	470	339	5	3.9	3.7	<2	55	28	11	2	255	<5	56	15	0.3	<0.1		0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 405	26-Jun-97		13.8	8.4	282	210		56			56	23	6	<1	230	<5	9	2	<1	0.5	0.02	0.7	<0.1	0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 405	27-Aug-97	41.5 cfs	12	8.5	365	230		32		<2	62	27	11		257	<5	14	3	0.2	0.5	<0.01	6.5	<0.1	0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 405	22-Oct-97	22 cfs	3.4	8.36	435	210	437	190	5.2	<2	39	23	10	<1	265	<5	13	4	0.2	0.5	0.01	5.4	<0.1	<0.1	<0.1	<0.01		<0.01		<0.01		<0.1		<0.2	<0.1	0.05
Pines 405	30-Jun-98					155	<5	81.5	6.2	<2	43	20	5	<1	257	<5	<10	<1		0.2	<0.1		1.9		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 405	17-Sep-98		14.8	8.2	410	152	756	725	4.4	<2	39	21	15	<1	300	<5	11	3	0.2	0.6	<0.01	3.4	<0.1	0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 406	27-Aug-97	39.6 cfs	15	8.5	355	210		31		<2	60	27	11		262	<5	28	3	0.1	0.6	<0.01	3.4	<0.1	0.1	<0.1	<0.01		<0.01		<0.01		<0.1		<0.2	<0.1	0.03
Pines 406	22-Oct-97	26.8 cfs	6.6	8.37	435	250	409	210	5.5	<2	25	22	11	<1	277	<5	11	4	0.2	0.5	0.01	4	<0.1	<0.1	<0.1	<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 406	30-Jun-98					120	233	109	6.7	<2	43	19	5	<1	258	<5	<10	4	0.1	<0.1		1.6		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 406	17-Sep-98		14.8	8.3	390	88	562	665	4.6	<2	39	22	16	<1	291	<5	11	3	0.2	0.6		12.2		0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 407	29-Oct-97	39																																			
Pines 407	16-Sep-98		12.1	8.4	340	9532	10	6.1	8.3	<2	46	17	9	2	209	<5	42	12	0.2	<0.1			<0.1	<0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 407	29-Jun-98		15.3	8.53	360	240	<5	3.1	4.4	<2	43	18	13	2	168	24	43	13	0.2	<0.1		5.2		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 408	29-Oct-97	20																																			
Pines 408	29-Jun-98		18.8	8.54	390	250	<5	2.9	5.2	<2	47	16	10	2	221	<5	36	14	0.2	<0.1		<0.1		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
Pines 408	16-Sep-98		15	8.3	390	290	59	15.5	5.5	<2	52	17	10	1	236	<5	34	13	0.3	<0.1		0.5		<0.1		<0.01	<0.01		<0.01		<0.1		<0.2				
SUFCO 090	27-Jul-89	0.021	19	7.03	127	118					20.08	5.17	5.54	3.16	55	0	32	5.8				0.14		0.02												
SUFCO 090	22-Aug-89	0.078	17	6.5	247	98					21.87	5.58	5.07	2.2	67	0	26	5.7				0.64		0.04												
SUFCO 090	18-Sep-89	0.052	6	6.2	221	110					20.36	5.22	5.3	1.6	67	0	24	5.4				0.11		0.01												
SUFCO 090	09-Oct-89	0.089	7	6.7	235	89					19.4	4.87	5.65	1.62	73	0	12	5.8				0.11		0.02												
SUFCO 090	23-May-90	0.064	19	7.2	159	50					20.5	5.15	5.66	1.76	60	0	15	6.9				0.14		0.02												
SUFCO 090	20-Aug-90	0.047	20.5	8.4	247	70					8.28	2.09	1.82	2.71	38	0	27	1.9				0.63		0.13												
SUFCO 090	15-Oct-90	0.035	12	7.4	176	115					17.65	4.41	9.13	1.8	77	0	12.5	6				0.12		0.01												
SUFCO 090	29-May-91	0.058	13.6	7.3	207	104					22.19	5.27	9.15	1.5	73	0	13.9	6.1				0.17		0.04												
SUFCO 090	27-Aug-91	0.076	12	7.56	155	88					19.63	5.73	5.66	1.28	83	0	10.2	5.4				0.24		0.033												
SUFCO 090	03-Oct-91	0.042	9.9	7.45	171	94					20.31	5.42	5.57	1.05	81	0	13.3	6.7				0.11		0.025												
SUFCO 090	12-May-92	0.042	14	8.35	136	88					21.45	5.04	5.77		69.1	0.2	12	5.3				0.07		0.06												
SUFCO 090	04-Aug-92	0.03	16	7.08	185	90						3.99	4.99	1.45	58	0	11	7.3				0.24		0.02												
SUFCO 090	06-Oct-92	0.056	12.5	7.36	178	110					13.9	4.4	6.85	1.64	44	0	12	7.8				0.21		0.08												
SUFCO 090	09-Jun-93	0.082	14	7.49	207	102					23.4	6.08	5.57	1.61	73.1	0	14.6	5.92				0.14		0.2												
SUFCO 090	11-Aug-93	0.07	13	7.88	200	66					21.4	5.91	6.4	1.48	70.2	0	11.3	4.91				0.11		0.2												
SUFCO 090	04-Oct-93	0.058	13	7.53	183	98					18.8	5.25	5.56	1.45	64.6	0	12.9	6.02				0.1		0.02												
SUFCO 090	07-Jun-94	0.053	17.5	7.54	169	121					18.3	4.59	6.42	1.1	74	0	12.5	8				0.15		0.01												
SUFCO 090	22-Aug-94	0.023	23.3	8.21	177	102					19	5	8	2	56	0	19	6				0.05		0.01												
SUFCO 090	05-Jun-95	0.08	20.4	7.92	209	170					21	7	12	2	70	0	16	7				0.2		0												
SUFCO 090	24-Aug-95	0.09	16.5	7.8	210	130					24	5	6	3	92	0	9	6				0.1		0												
SUFCO 090	03-Oct-95	0.12	16.4	8.12	203	40					18	4	5	1	85	0	5	8				0.1		0												

PETERSEN HYDROLOGIC

7 November 2018

Ms. Vicky Miller
Environmental Engineer
Canyon Fuel Company, LLC, Sufco Mine
597 South SR24
Salina, UT 84654

Vicky,

At your request, we have performed a hydrogeologic evaluation of spring Pines 310 at the Canyon Fuel Company, LLC Sufco Mine. Our findings in this regard are presented in the letter report that follows below.

Hydrologic Evaluation of Spring Pines 310 and the
Proposed Mining of the
Pines Panels at the Sufco Mine.

Introduction

Pines 310 is a spring located in The Pines area at the Canyon Fuel Company, LLC Sufco Mine (Figure 1). Discharge from Pines 310 for the period from June 2014 through September 2018 averages 0.34 gpm (Table 1, Figure 2). The Sufco Mine proposes to mine longwall mining panels located at The Pines mining district within the existing mine permitted area (Figure 1). Spring Pines 310 is located approximately 0.84 miles northwest of the closest mine workings of the proposed Pines Panels, and 1.0 miles northwest of the mine workings along a probable groundwater flow path (Figure 1). It is noted that there are two potential layouts shown on Figure 1 for the proposed Pines Panels layouts. One potential layout is shown in Black, the other in blue. Coal mining

operations were previously conducted in the Pines mining district at locations west of the Pines 310 location.

Spring Pines 310 Groundwater Regime

Pines 310 discharges from a groundwater system in the Cretaceous Castlegate Sandstone. The Castlegate is a cliff-forming sandstone of fluvial origin that is comprised predominantly of resistant sandstone with thin, interbedded layers of low-permeability siltstones and shale that are distributed locally throughout the formation (Thiros and Cordy, 1991). The Castlegate Sandstone within The Pines area dips to the northwest at about 2 degrees and is intensely jointed and fractured naturally in the Pines 310 area (Thiros and Cordy, 1991; Figure 3). The primary fracture orientation is north, 26 degrees west. Within the region surrounding Pines 310, the Castlegate sandstone is exposed directly at the land surface or covered only by a thin veneer of sand or sandy soil (Figure 3).

Recharge to Pines 310 occurs in up-dip areas (southeast of the spring) on the Pines plateau surface. Groundwater movement in the Castlegate Sandstone coincides generally with the direction of bedrock dip and orientation of bedrock fracturing, both of which trend generally towards the northwest (Figures 1 and 3). Fracturing and jointing of the rocks in the Castlegate Sandstone potentially providing conduits for rapid groundwater movement (Thiros and Cordy, 1991). As shown on Figure 1, potential recharge areas are constrained to regions within the upland plateau only, as the land surfaces further to the north, east, and south are truncated by the presence of the precipitous Muddy Creek Canyon escarpment (Figure 1). It is apparent in field observations that spring Pines 310 discharges to the surface as a perched groundwater system with groundwater flow occurring on a low-permeability shaley layer which is less than about 6 inches thick. The spring discharges at an elevation only a few tens of feet below the elevation of the top of the plateau surface directly south of the spring, suggesting shallow groundwater circulation depths. Additionally, the low dissolves solids concentrations of groundwaters discharging from Pines 310, as reflected by the specific conductance values (Table 1), are

suggestive that the groundwater discharging at the spring has not encountered sediments of the Price River Formation. Such sediments are present on the top of the plateau surface to the south of the Pines 310 area within the northern portions of the proposed Pines Panels areas (See Plate 1 in Thiros and Cordy, 1991). In the Sufco Mine area, groundwaters that have interacted with Price River Formation sediments commonly have specific conductance values that are about an order of magnitude greater than waters from the Castlegate Sandstone that have not come into contact with Price River Formation sediments (see data for monitoring sites GW-13, GW-8, and M-SP87 in the Division of Oil, Gas and Mining on-line coal water quality database). This information suggests that shallow Price River Formation groundwaters from the northern portion of the proposed Pines Panels location do not contribute appreciably to the groundwater currently discharging at Pines 310.

Thiros and Cordy (1991), as part of a United States Geological Survey study, estimated that recharge to the Castlegate Sandstone is about 1.2 percent of the annual average precipitation, with groundwater recharge occurring primarily from the infiltration of precipitation. Precipitation in the Sufco Mine area has been monitored at National Weather Service weather station Salina 24E since 1984, with the average annual precipitation during this period of 13.8 inches. Using the average annual discharge from the Pines 310 spring (0.34 gpm, or 0.55 acre-feet per year), the average annual precipitation (13.8 inches), and the reported recharge rate (1.2% of annual recharge), it is possible to calculate a hypothetical recharge area associated with the discharge at spring Pines 310. Using these values it is determined that a region of approximately 39.7 acres would provide the groundwater recharge to the Castlegate Sandstone that would support the 0.34 gpm average discharge from spring Pines 310. Using this information in conjunction with the direction of bedrock dip and the primary fracture orientation, a hypothetical groundwater recharge area for Pines 310 is plotted on Figure 4. It is noteworthy that the calculated hypothetical recharge area is relatively small, with the recharge area existing in close proximity to the spring discharge location. This is consistent with the apparent shallow depth of groundwater circulation along the perched

groundwater flowpath that leads to the spring (i.e. a shallow, local groundwater system that is recharged from direct infiltration of local precipitation in the nearby vicinity of the spring). Using a reasonably plausible groundwater flowpath/recharge area geometry (based on the direction of dip and fracturing locations and orientations) a length of the hypothetical area is about 2,850 feet (0.54 miles; Figure 4).

Potential for impacts to spring Pines 310 associated with mining the Pines Panels

Based on the information presented above, it is considered unlikely that mining of the Pines Panels will impact discharge rates or water quality at spring Pines 310. The basis of this conclusion is summarized below:

- The spring Pines 310 is *one mile* away from the proposed Pines Panels location in the up-gradient direction (i.e. up dip and generally along the primary fracture trend). The spring is 0.85 miles away from the nearest portion of the Pines Panels mining area. This large buffer between proposed Pines Panels mining areas and Pines 310 minimizes the potential for impacts to water quantity or quality at the spring.

- The calculated hypothetical recharge area for the spring (Figure 4) does not intersect the proposed Pines Panel mining areas. Rather it is separated from the proposed Pines Panels mining area by about 2,400 feet (Figures 1 and 4). Thus, based on this information, there would be little possibility that mining in the Pines Panels area could impact discharge rates or water quality at spring Pines 310.

- Water quality information from groundwater discharging from Pines 310 does not indicate that appreciable quantities of the groundwater arriving at the spring has intermingled with Price River Formation sediments – such as those present in the northern portions of the proposed Pines Panels area.

Based on this information, it is our opinion that the potential for impacting groundwater quantity or quality at spring Pines 310 as a result of mining in the Pines Panels area is low.

References Cited

Thiros, S.A., and Cordy, G.E., 1991, Hydrology and potential effects of mining in the Quitchupah and Pines coal-lease tracts, central Utah, U.S. Geological Survey, Water-Resources Investigations Report 90-4084.

Please feel free to contact me should you have any questions in this regard.

Sincerely,

Erik C. Petersen, P.G.
Principal Hydrogeologist
Utah PG #5373615-2250

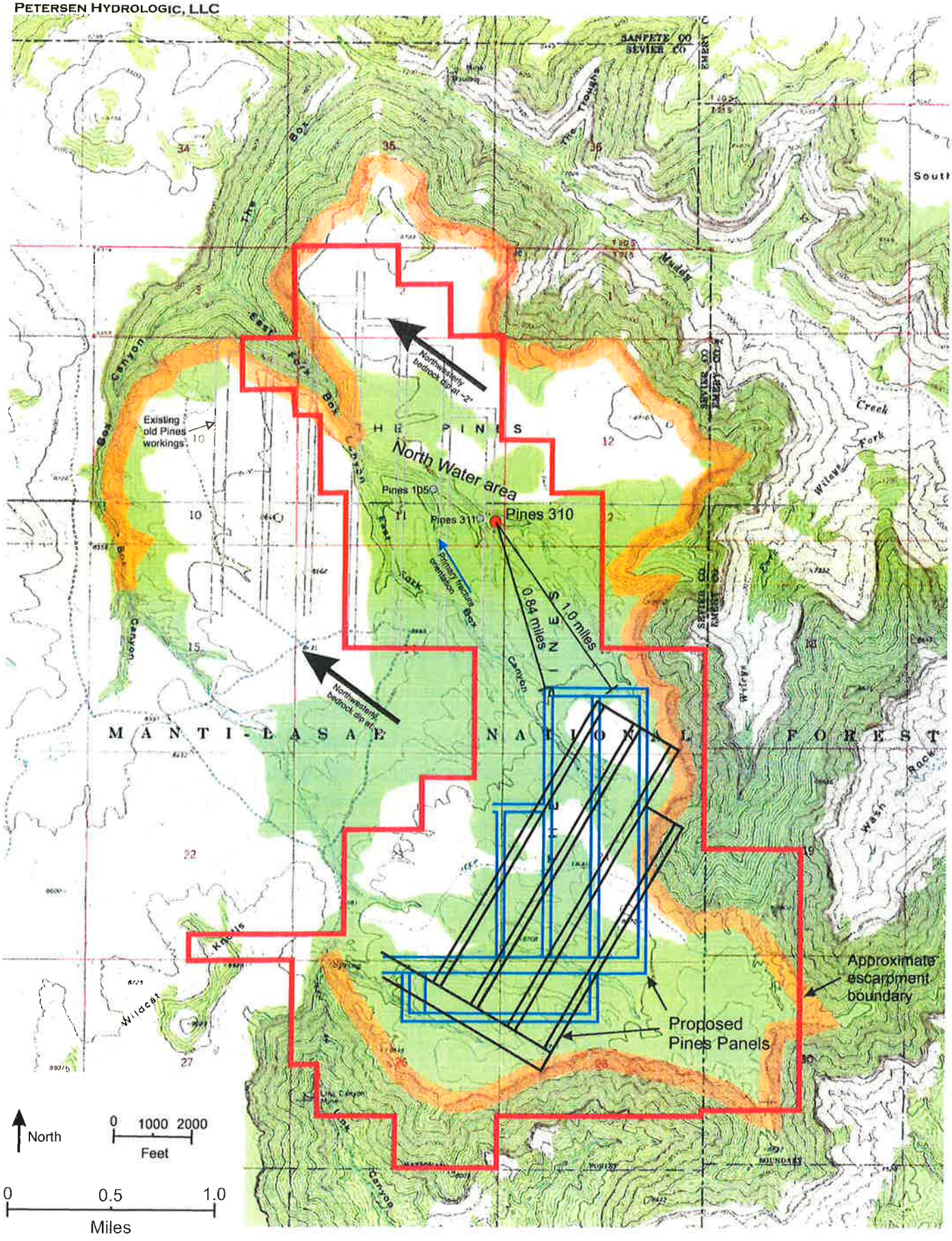

Figure 1 Locations of spring Pines 310 and the proposed Pines Panels mine workings

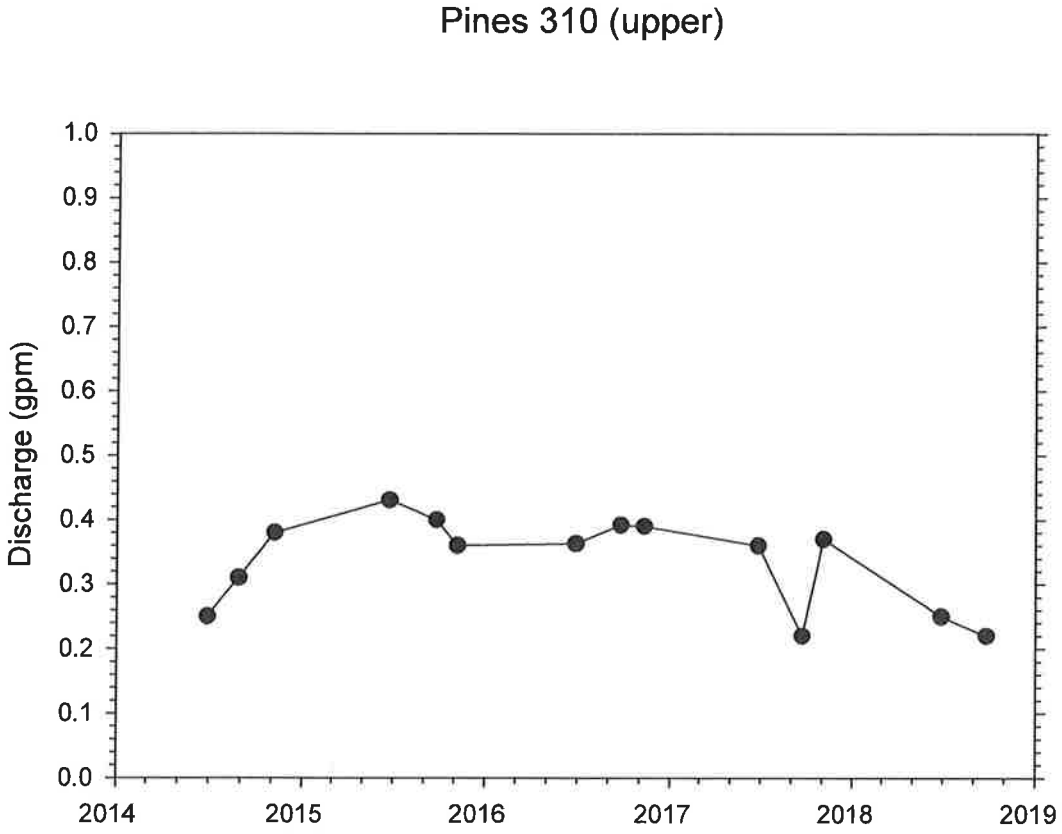

Figure 2 Discharge hydrograph for spring Pines 310 upper.

Figure 3 Photographic image showing the naturally occurring Castlegate Sandstone fracturing/jointing patterns (best expressed in the center of the image) and Castlegate Sandstone bedrock exposure at the land surface up-gradient of the Pines 310 spring location.

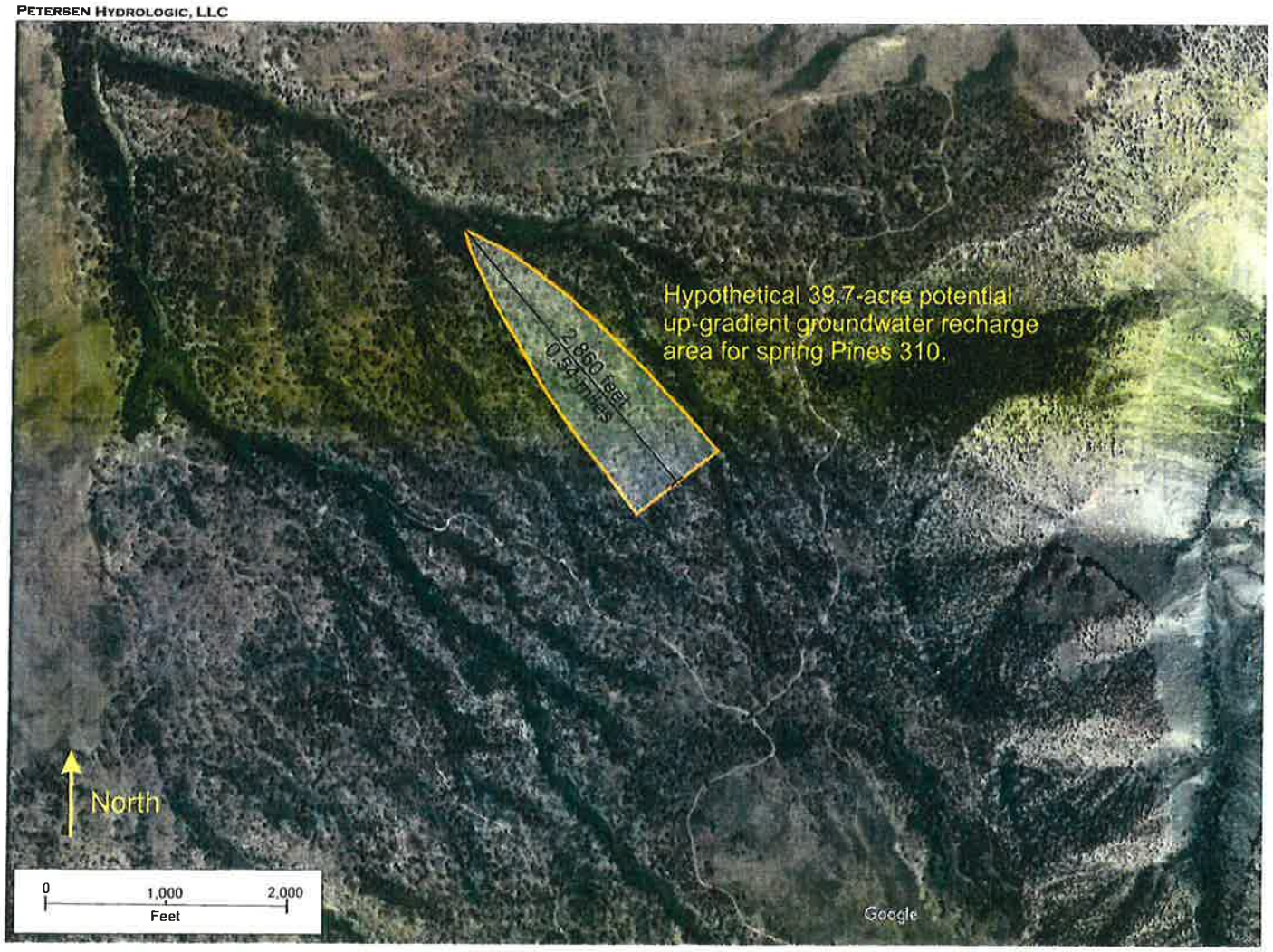

Figure 4 39.7-acre region up-gradient of spring Pines 310 (upper). This represents a hypothetical region that could potentially support adequate recharge to sustain the 0.34 gpm average discharge rate from the spring (based on USGS estimate of 1.2% of average annual precipitation recharging the Castlegate Sandstone and 13.8 inch average precipitation at the Sufco Mine area).

Table 1 Discharge and water quality data for Pines 310 (upper).

DATE	Wat. Temp Deg. C	Flow GPM	Cond(FLD) umhos/cm	F-pH pH units
9/26/2018	8.0	0.22	191	7.11
6/28/2018	6.9	0.25	213	7.46
11/3/2017	6.3	0.37	180	7.51
9/22/2017	10.3	0.22	226	7.5
6/25/2017	6.8	0.36	178	6.98
11/10/2016	6.7	0.39	183	7.44
9/24/2016	7.9	0.392	195	7.59
6/27/2016	7.1	0.363	176	7.19
11/6/2015	4.2	0.36	186	7.67
9/25/2015	8.1	0.4	168	7.37
6/23/2015	8.7	0.431	207	7.67
11/6/2014	6.6	0.38	180	7.2
8/28/2014	8.1	0.31	169	7.27
6/28/2014	6.3	0.25	174	7.12
Average:	**7.3**	**0.34**	**188**	**7.36**

CHAPTER 9

ALLUVIAL VALLEY FLOOR

TABLE OF CONTENTS (December 20, 1991)

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3.2.2 Operations Affecting Designated Alluvial Valley Floor 9-7

LIST OF PLATES

Plate

9-1 Alluvial Valley Floor Characteristics Determination

LIST OF APPENDICES

(Appendices appear in Volume 9)

Appendix

9-1 Environmental Assessment for Quitchupah Lease

3.2.2 Operations Affecting Designated Alluvial Valley Floor

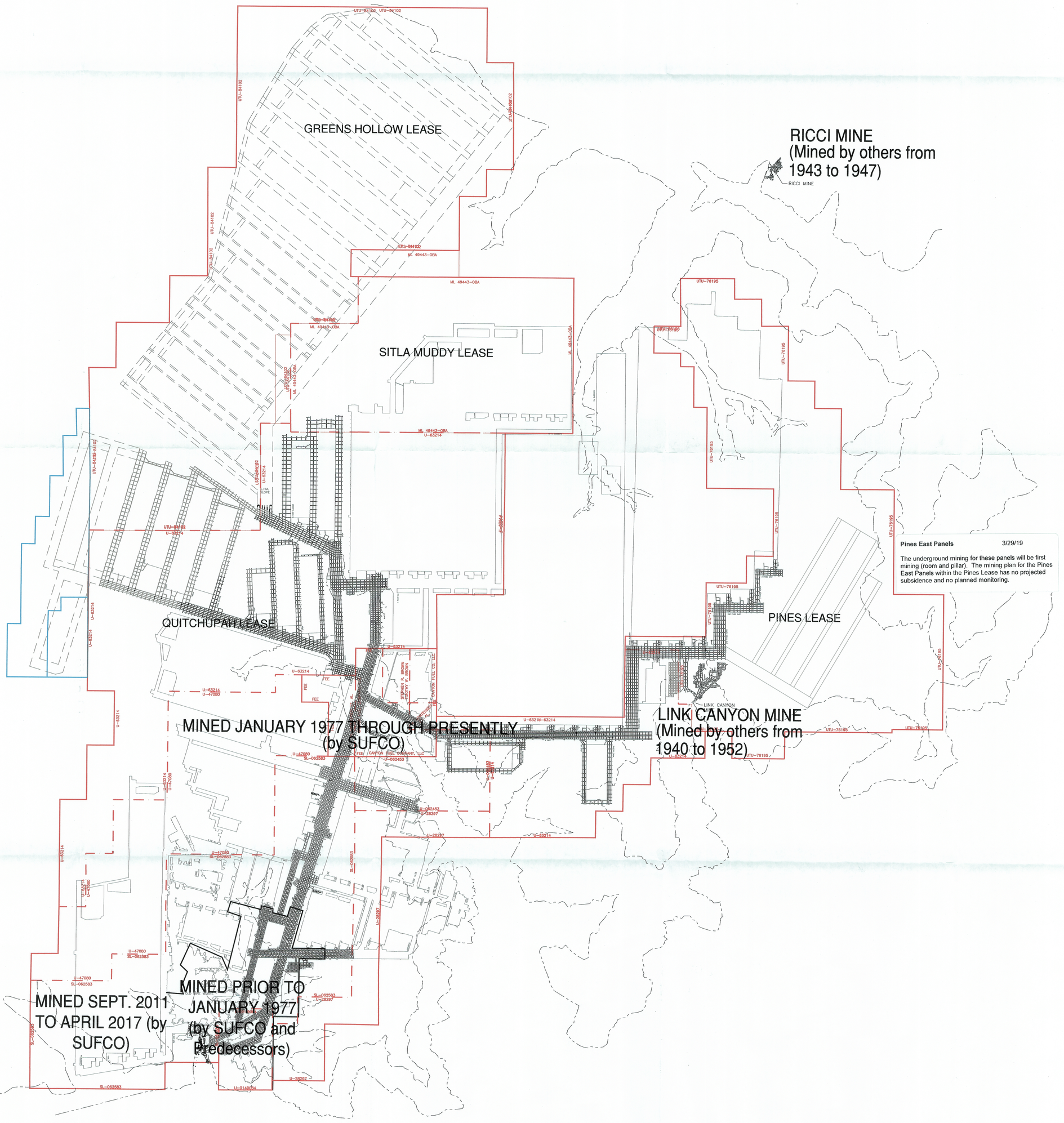
Based on hydrology and geology of the mine permit area and the adjacent area, there appear to be no alluvial valley floors in these areas. A possible AVF exists in the general area along Quitchupah Creek downstream of the adjacent area boundary. Approximately 110 acres are being irrigated at this location (Plate 9-1). There appear to be no other potential alluvial valley floors in the general area.

All of the surface on the Quitchupah Lease is owned by the United States. The surface management agencies (USFS and BLM) have determined that no alluvial valley floors exist on the lease. Their finding is documented on page 6 in the Environmental Assessment for the Quitchupah Lease Tract included as Appendix 9-1.

All of the surface on the Pines Tract Lease is owned by the United States. Based on the above discussions, the Natural Resources Conservation Service Determination on the Pines Tract (located in Appendix 2-1), and the information provided in Chapters 2, 3, 6, and 7, alluvial valley floors are not present within the Pines Tract.

All of the surface on the SITLA Muddy Tract Lease is owned by the United States. Based on the above discussions, and the information provided in Chapters 2, 3, 6, and 7, alluvial valley floors are not present within the SITLA Muddy Tract.

The Greens Hollow Tract Lease is owned by the United States. Based on the above discussions, and the information provided in Chapters 2, 3, 6, and 7, alluvial valley floors are not present within the Tract.



EXPLANATION

- MINED AREA BOUNDARY
- OUTCROP
- ESCARPMENT
- EXTERIROR LEASE BOUNDARY
- INTERIOR LEASE BOUNDARY
- PROPOSED LEASE BOUNDARY

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

PROFESSIONAL ENGINEER
No. 9073281
JACOB D. SMITH
STATE OF UTAH
3/5/19

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

2000 0 2000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
2	1/20/2005	M.L.D.	B.D.H.	
3	5/8/2007	M.L.D.	K.B.B.	
4	6/11/2010	M.L.D.	K.B.B.	
5	3/2/2015	V.M.	T.R.B.	ADDED 70 ACRE R.O.W. AREA FOR S WEST
6	4/12/2017	V.M.	B.R.	GREENS HOLLOW
7	3/27/2018	V.M.	B.R.	GREENS HOLLOW TECHNICAL ANALYSIS
8	10/31/2018	V.M./B.B.	J.G.C.	ADD PINES EAST AND SOUTH FORK
9	1/15/2019	V.M.	J.G.C.	MODIFIED PINES EAST

PEN TBL: _SStndrd-SUFCNP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

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

PREVIOUSLY MINED AREAS

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 2,000'	6/18/1999	A.D.D.		M.L.D.	PLATE 5–1

FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 5–1.dwg

GREENS HOLLOW LEASE

SITLA MUDDY LEASE

QUITCHUPAH LEASE

PINES LEASE

FUTURE LOWER HIAWATHA POINT OF ACCESS FROM UPPER HIAWATHA

RICCI MINE

LINK CANYON MINE

UTU-84102

UTU-76195

U-63214

ML 49443-OBA

U-47080

SL-062583

U-28297

U-0149084

FEE

PB 38

PB 39

PB 40

PB 41

PB 42

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- ESCARPEMENT
- OUTCROP
- PROPOSED LEASE BOUNDARY

MINING LEGEND

REMAINING 2017	2019
1ST QUARTER 2018	2020
2ND QUARTER 2018	2021
3RD QUARTER 2018	2022
4TH QUARTER 2018	

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

PROFESSIONAL ENGINEER
No. 9073281
JACOB D. SMITH
3/5/19
STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

1500 0 1500

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
12	4/13/2017	V.M.	B.R.	GREENS HOLLOW
13	12/19/2017	B.B.	B.R.	Add 4R4E Panel
14	3/27/2018	V.M.	B.R.	GREEN HOLLOW TECHNICAL ANALYSIS
15	10/31/2018	V.M./B.B.	J.G.C.	ADDED PROPOSED SOUTH FORK LEASE
16	1/15/2019	V.M.	J.G.C.	ADDED PINE EAST

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

SUFCO MINE PLAN
5 YEAR PROJECTION

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
_15Mnhrd-SUFEMP1.ctb	1" = 1,500'	03/01/2000	B.D.H.	JDB	VM	PLATE 5-7
SHT SET: ####	PROJECT NUMBER: ####	FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 5-7.dwg				

GREENS HOLLOW LEASE

SITLA MUDDY LEASE

QUITCHUPAH LEASE

PINES LEASE

UTU-84102 U-63214 ML 49443-OBA U-62453 U-28297 U-47080 SL-062583 U-0149092 UTU-76195

PINES EAST PANELS 3/27/2019

THE UNDERGROUND MINING FOR THESE PANELS WILL BE FIRST MINING (ROOM AND PILLAR). THE MINING PLAN FOR THE PINES EAST PANELS WITHIN THE PINES LEASE HAS NO PROJECTED SUBSIDENCE AND NO PLANNED MONITORING.

EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- 100000 MC — MINE COORDINATES
- 2020000 SPC — STATE PLANE COORDINATES
- PROPOSED LEASE BOUNDARY
- CONTROL POINT
- AERIAL TARGET
- LIMIT OF POTENTIAL SUBSIDENCE
- UNDERGROUND PERENNIAL STREAM AND PROTECTED CULTURAL SITE BUFFER CORRIDOR

PINES EAST PANELS 3/27/2019

THE UNDERGROUND MINING FOR THESE PANELS WILL BE FIRST MINING (ROOM AND PILLAR). THE MINING PLAN FOR THE PINES EAST PANELS WITHIN THE PINES LEASE HAS NO PROJECTED SUBSIDENCE AND NO PLANNED MONITORING.

PROFESSIONAL ENGINEER No. 9073291 JACOB D. SMITH STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

1000 0 1000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
3	4/16/2017	V.M.	B.R.	GREENS HOLLOW
4	12/8/2017	V.M.	B.R.	ADD 3R4E & 4R4E
5	3/19/2018	V.M.	B.R.	GREENS HOLLOW TECHNICAL ANALYSIS
6	10/31/2018	V.M./B.B.	J.G.C.	SUB LIMITS FOR PINES EAST & SOUTH FORK
7	1/15/2019	V.M.	J.G.C.	REVISED SUB LIMITS FOR PINES EAST
8	3/27/2019	V.M.	J.G.C.	REMOVED SUB LIMITS FOR PINES EAST

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POTENTIAL SUBSIDENCE LIMITS

SCALE:	DATE:	DRAWN BY:	ENGINEER:	SHEET NO.
1" = 1000'	08/13/09	JMB		PLATE 5-10
CHECKED BY: WKS	FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 5-10.dwg			

GREENS HOLLOW LEASE

SITLA MUDDY LEASE

QUITCHUPAH LEASE

PINES LEASE

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- 100000 MC — MINE COORDINATES
- 2020000 SPC — STATE PLANE COORDINATES
- PROPOSED LEASE BOUNDARY

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

PROFESSIONAL ENGINEER — No. 9073281 — JACOB D. SMITH — STATE OF UTAH — 3/5/19

2000 0 2000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
6	12/15/2016	V.M.	T.L.M.	REMOVE SOUTH FORK LEASE BOUNDARY
7	4/18/2017	V.M.	B.R.	GREENS HOOLOW
8	10/18/2017	B.B.	B.R.	Add 4R4E Panel
9	3/27/2018	V.M.	B.R.	GREENS HOLLOW TECHNICAL ANALYSIS
10	10/31/2018	V.M./B.B.	J.G.C.	ADDED PROPOSED SOUTH FORK LEASE AND MINING IN SOUTH FORK AND PINES EAST
11	1/15/2019	V.M.	J.G.C.	MODIFIED PINES EAST

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

OVERBURDEN ISOPACH MAP

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
!Slabd-SUFDIP1.ctb	1" = 2,000'	01/20/2005	BDH/TRB	JDB	VM	PLATE 5-11
SHT SET: ####	PROJECT NUMBER: ####	FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 5-11.dwg				

jbcristensen 1/17/2019 9:54 AM

GREENS HOLLOW LEASE

SITLA MUDDY LEASE

QUITCHUPAH LEASE

PINES LEASE

A–A' CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

B–B' CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

C–C' CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

D–D' CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

NOTE:
1. CONTACTS HAVE NOT BEEN FIELD CHECKED.
2. FAULTS PROJECTED TO SURFACE FROM MINE

EXPLANATION

- UPPER HIAWATHA COAL SEAM OUTCROP
- EXTERIOR LEASE BOUNDARY
- INTERIOR LEASE BOUNDARY
- MINE BASE COORDINATES
- STATE PLANE COORDINATES
- US–79–2 (8497) — DRILLHOLE LOCATION AND NUMBER / DRILLHOLE SURFACE ELEVATION
- PROPOSED LEASE BOUNDARY
- FORMATION OR MEMBER CONTACT
- FAULTS WITH GREATER THAN 2' DISPLACEMENT MAPPED IN MINE
- A'------A — CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)
- PROPOSED NEWLY BUILT ACCESS ROUTES
- PROPOSED ACCESS ROUTES USING EXISTING WHEEL TRACKS OR EXISTING SURFACE

GEOLOGIC KEY

AGE	SYMBOL	NAME
QUATERNARY	Qa	ALLUVIUM, HILL WASH, SLUMPS UNDIFFERENTIATED
TERT–CRET	T–Knh	NORTH HORN FORMATION
CRETACEOUS	Kpr	PRICE RIVER FORMATION
"	Kc	CASTLEGATE SANDSTONE FORMATION
"	Kbh	BLACKHAWK FORMATION–UPPER MEMBER
"	Ksp	BLACKHAWK FORMATION–STARPOINT SANDSTONE MEMBER
"	Kmm	MANCOS SHALE–MASUK MEMBER

1.5 / N 42 E — CALCULATED STRIKE AND DIP TOP UPPER HIAWATHA COAL SEAM

COAL BURN

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

PROFESSIONAL ENGINEER — No. 9073281 — JACOB D. SMITH — STATE OF UTAH — 3/5/19

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

2000 0 2000

SOURCES:

1. QUITCHUPAH LEASE ADDITION, VOLUME 10, MAPS 5.2, 5.3, 6.1, 1989
   HYDROMETRICS INC.
   SOUTHERN UTAH FUEL COMPANY'S HYDROLOGICAL RESPONSE TO OSM'S APPARENT COMPLETENESS REVIEW
2. MANTI–LA SAL NATIONAL FOREST–PINES TRACT PROJECT FINAL ENVIRONMENTAL IMPACT STATEMENT (FEIS) FIGURE 3–1 GEOLOGY MAP JANUARY 1999 USDA FOREST SERVICE, REGION FOUR MANTI–LA SAL NATIONAL FOREST EMERY AND SEVIER COUNTIES, UTAH
3. COAL TRACT EVALUATIONS ON THE MANTI–LASAL NATIONAL FOREST MUDDY CREEK AND NORTH HORN SURFACE AND GROUND WATER TECHNICAL REPORTS FIGURE 2 GEOLOGY MAP WITH SPRING LOCATIONS. MUDDY COAL TRACT EIS, EMERY CO. UTAH OCTOBER 2004

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
8	03/02/2015	V.M.	T.R.B.	ADDED70 ACRE R.O.W. AREA FOR S WEST
9	07/14/2016	V.M.	J.G.C.	ADD GREEN HOLLOW & SOUTH FORK LEASE BOUNDARIES
10	12/15/2016	V.M	T.L.M.	REMOVE SOUTH FORK BOUNDARY
11	4/18/2017	V.M.	B.R.	GREENS HOLLOW
12	10/3/2017	V.M.	B.R.	Castle Gate Sandstone
13	11/7/2018	V.M.	J.G.C.	ADDED 2018 DRILLING

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597 South SR 24 – Salina, UT 84654
(435) 286–4880 Phone
(435) 286–4499 Fax

GEOLOGY & DRILL HOLE LOCATION MAP

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
JShdd-SUFDPI.ctb	1" = 2,000'	3/5/2015	KJW/TRB	JDB	VM	PLATE 6–1
SHT SET: ####	PROJECT NUMBER: ####	FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 6-1.dwg				

johndaresan, 11/7/2018, 3:37 PM

GREENS HOLLOW LEASE

SITLA MUDDY LEASE

QUITCHUPAH LEASE

PINES LEASE

A–A' CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

B–B' CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

C–C' CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

D–D' CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)

NOTE:
1. CONTACTS HAVE NOT BEEN FIELD CHECKED.
2. FAULTS PROJECTED TO SURFACE FROM MINE

EXPLANATION

- UPPER HIAWATHA COAL SEAM OUTCROP
- EXTERIOR LEASE BOUNDARY
- INTERIOR LEASE BOUNDARY
- MINE BASE COORDINATES
- STATE PLANE COORDINATES
- US–79–2 (8497) — DRILLHOLE LOCATION AND NUMBER / DRILLHOLE SURFACE ELEVATION
- PROPOSED LEASE BOUNDARY
- FORMATION OR MEMBER CONTACT
- FAULTS WITH GREATER THAN 2' DISPLACEMENT MAPPED IN MINE
- A'------A — CROSS–SECTION (SEE PLATE 6–2, 6–3, 6–4 AND 6–5)
- PROPOSED NEWLY BUILT ACCESS ROUTES
- PROPOSED ACCESS ROUTES USING EXISTING WHEEL TRACKS OR EXISTING SURFACE

GEOLOGIC KEY

AGE	SYMBOL	NAME
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TERT–CRET	T–Knh	NORTH HORN FORMATION
CRETACEOUS	Kpr	PRICE RIVER FORMATION
"	Kc	CASTLEGATE SANDSTONE FORMATION
"	Kbh	BLACKHAWK FORMATION–UPPER MEMBER
"	Ksp	BLACKHAWK FORMATION–STARPOINT SANDSTONE MEMBER
"	Kmm	MANCOS SHALE–MASUK MEMBER

1.5 / N 42 E — CALCULATED STRIKE AND DIP TOP UPPER HIAWATHA COAL SEAM

COAL BURN

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

PROFESSIONAL ENGINEER — No. 9073281 — JACOB D. SMITH — STATE OF UTAH — 3/5/19

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

2000 0 2000

SOURCES:

1. QUITCHUPAH LEASE ADDITION, VOLUME 10, MAPS 5.2, 5.3, 6.1, 1989
   HYDROMETRICS INC.
   SOUTHERN UTAH FUEL COMPANY'S HYDROLOGICAL RESPONSE TO OSM'S APPARENT COMPLETENESS REVIEW
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3. COAL TRACT EVALUATIONS ON THE MANTI–LASAL NATIONAL FOREST MUDDY CREEK AND NORTH HORN SURFACE AND GROUND WATER TECHNICAL REPORTS FIGURE 2 GEOLOGY MAP WITH SPRING LOCATIONS. MUDDY COAL TRACT EIS, EMERY CO. UTAH OCTOBER 2004

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
8	03/02/2015	V.M.	T.R.B.	ADDED70 ACRE R.O.W. AREA FOR S WEST
9	07/14/2016	V.M.	J.G.C.	ADD GREEN HOLLOW & SOUTH FORK LEASE BOUNDARIES
10	12/15/2016	V.M	T.L.M.	REMOVE SOUTH FORK BOUNDARY
11	4/18/2017	V.M.	B.R.	GREENS HOLLOW
12	10/3/2017	V.M.	B.R.	Castle Gate Sandstone
13	11/7/2018	V.M.	J.G.C.	ADDED 2018 DRILLING

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GEOLOGY & DRILL HOLE LOCATION MAP

PEN TBL:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
JShdd-SUFDPI.ctb	1" = 2,000'	3/5/2015	KJW/TRB	JDB	VM	PLATE 6–1
SHT SET: ####	PROJECT NUMBER: ####	FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 6-1.dwg				

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GREENS HOLLOW LEASE

SITLA MUDDY LEASE

QUITCHUPAH LEASE

PINES LEASE

94-513 94-464 94-370 94-422 94-465 94-466 94-509 94-507 94-502 94-481 94-469 94-597 94-467 94-453 94-468 94-596 94-450 94-469 94-468 94-467 94-449 94-470 94-481 94-482 94-483 94-487 94-473 94-478 94-472 94-449 94-449 94-449 94-451 94-452 94-476 94-454 94-476 94-455 94-463 94-462 94-425 94-592 94-445 94-474 94-475 94-457 94-458 94-456 94-480 94-477 94-459 94-436 94-444 94-442 94-437 94-438 94-440 NORTH PINES #2 WEST PINE THE PINES 94-439 94-435 EAST DRAW BIG RIDGE 94-443 94-441 94-434 SOUTH DRAW BIG RIDGE UNNAMED 94-433 SLAB 94-431 BOX POND 94-432 VERDUS JOE'S MILL PONDS 94-364 94-362 94-361 94-363 94-352 94-351 94-424 94-360 94-447 94-448 94-446 94-442 94-460 94-1400 94-1406 63-2883 94-1396 94-1408 63-3383 94-1405 94-1109 94-1409 94-1404 63-3382 94-1415 94-1414 63-3380 94-1396 94-1403 94-1413 94-1412 63-3395 63-3365 63-3373 63-3374 94-111 94-1392 94-1397 94-1393 94-1399 94-1386 BOUNDARY RES. 95-977 94-1394 MIDDLE RES. 94-1411 94-113 94-112 94-1410 94-1396 94-1397 94-114 94-1388 63-2884 94-115 NORTH DUNCAN 94-116 NORTH DUNCAN FLAT RES. 63-2885 94-126 94-118 94-117 UPPER DUNCAN DRAW 94-1387 95-984 95-981 94-1399 94-1401 MIDDLE DUNCAN 94-121 94-1395 UPPER MUD SPRING 94-1130 94-1132 94-25 94-836 94-1133 94-1131 94-1389 95-986 94-120 LOWER DUNCAN 95-989 94-1391 95-988 94-122 MIDDLE MUD SPRING 94-123 94-124 95-991 (8280) 95-990 94-131 LITTLE DUNCAN 95-993 94-127 LOWER MUD SPRING 95-994 94-128 95-995 94-129 95-996 94-130 94-134 95-1000 94-1398 95-1001 94-135 94-87 94-1504 95-1003 94-137 94-1580 94-1593 94-119 EAST SPRING 95-998 95-997 94-125 94-132 94-133 95-999 94-1594 94-1398 94-588 DEWEYS 94-590 KENS HANSON'S 94-586 JENSEN 94-587 MILL 94-589 JOHNSON WEST BOX DRY POINT 94-585 ROCK 94-584 94-583 94-430 94-429 94-428 94-591 94-427 94-940 94-1717 94-941 94-934 94-935 94-936 94-942 94-943 94-1720 94-937 94-1102 94-944 94-939 94-938 94-946 94-945 94-1030 94-947 94-949 94-948 94-1289 94-1088 94-1060 94-1185 94-1218 94-1184 94-1183 94-1186 94-1290 94-1292 94-1291 94-1033 94-1032 94-1290 94-1580 94-137 94-1504 95-1001 94-135 94-1398 95-1003

T 20 S
T 21 S

SANPETE CO.
SEVER CO.
EMERY CO.

SCAB HOLLOW
MUDDY CREEK
GREENS CANYON
COWBOY CANYON
LINK CANYON
QUITCHUPAH CREEK
BEAVER CREEK FORK
SOUTH FORK
JULIUS FLAT RESERVOIR
BIG RIDGE
DUNCAN MOUNTAIN
CORRAL KNOLL
LINK CANYON MINE
NORTH DUNCAN FLAT RES.
SINKHOLE
OLD MINE WORKS
BOUNDARY RES.
MIDDLE RES.
NORTH DUNCAN
UPPER DUNCAN DRAW
LOWER DUNCAN
MIDDLE MUD SPRING
LOWER MUD SPRING
EAST SPRING
LITTLE DUNCAN
UPPER MUD SPRING
MIDDLE DUNCAN
JULIUS FLAT RESERVOIR

U-63214 U-47080 SL-062583 U-28297 U-62453 U-62583 U-28287 U-49443-OBA ML 49443-OBA UTU-84102 UTU-76195 FEE CANYON FUEL COMPANY, LLC

PB 36 PB 37 PB 38 PB 39 PB 40 PB 41

260000 SPC 150000 MC 250000 SPC 140000 MC 120000 MC 230000 SPC 240000 SPC 130000 MC 220000 SPC 110000 MC 210000 SPC 100000 MC 2020000 SPC 2040000 SPC 2060000 SPC

EXPLANATION

- SUFCO EXTERIOR LEASE BOUNDARY
- SUFCO INTERIOR LEASE BOUNDARY
- MINE COORDINATES (100000 MC)
- STATE PLANE COORDINATES (2020000 SPC)
- WATER RIGHT SPRING
- RUNOFF CATCHMENT POND W/ WATER RIGHT
- RUNOFF CATCHMENT POND W/O WATER RIGHT
- SURFACE WATER RIGHT POINT TO POINT
- SURFACE WATER RIGHT

NOTES:

1. SEE APPENDIX 7-1 FOR DETAILED LISTING OF WATER RIGHTS

- PROPOSED LEASE BOUNDARY

QUITCHUPAH TRACT

CATCHMENT PONDS WITH WATER RIGHTS NUMBER	NAME	CURRENT COMMON NAME USED BY USFS, CATTLEMEN AND OTHERS	OTHER HISTORICAL NAMES USED FOR CATCHMENT PONDS
94-115	NORTH DUNCAN RES.		
94-116	NORTH DUNCAN FLAT RES.		
94-117	UPPER DUNCAN DRAW RES.		
94-119	EAST SPRING RES.		
94-120	LOWER DUNCAN RES.		
94-122	MIDDLE MUD SPRING RES.		
94-123	SHORT HOLLOW RES.		
94-127	LOWER MUD SPRING RES.		
94-128	PIN HOLLOW RES.		
94-129	ELDRIDGE HOLLOW RES. #1		
94-130	ELDRIDGE HOLLOW RES. #2		
94-131	LITTLE DUNCAN RES.		
94-134	COLLIER RES.		
94-137	JOLLY MILL POINT RES.		
94-430	UNNAMED RES.	LINK CANYON #1	
94-431	UNNAMED RES.	BOX POND	TRIANGLE, THREE CORNER
94-434	UNNAMED RES.	SOUTH DRAW BIG RIDGE	
94-435	UNNAMED RES.	EAST DRAW BIG RIDGE	
94-436	UNNAMED RES.		
94-439	UNNAMED RES.		

QUITCHUPAH TRACT

CATCHMENT PONDS WITH WATER RIGHTS NUMBER	NAME	CURRENT COMMON NAME USED BY USFS, CATTLEMEN AND OTHERS	OTHER HISTORICAL NAMES USED FOR CATCHMENT PONDS
94-444	UNNAMED RES.		
94-583	DRY POINT RES.		
94-584	SEEPS RES.	SEEPS POND	
94-585	WHITE KNOLL RES.	ROCK POND	
94-586	BOX CANYON RES.	JENSEN	
94-587	MILL RES.	MILL POND	
94-588	DWEYS RES.	DEWYS POND	
94-589	SAGE CREEK RES.	JOHNSON POND	JENSEN, SAGE GROUSE POND
94-590	KENS RES.		
94-592	BIG RIDGE RES.		
94-730	QUITCHUPAH RES. #1	QUITCHUPAH RES. #1	
94-1386	BOUNDARY RES.		
94-1394	MIDDLE RES.		
94-1395	UPPER MUD SPRINGS RES.		
94-1401	MIDDLE DUNCAN RES.		
94-1580	JOLLY MILL GUZZLER RES.		
OTHER CATCHMENT PONDS WITHOUT WATER RIGHTS			
		WEST BOX	
		DRY POINT	
		HANSON'S POND	JOHNSON, HANS

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

PROFESSIONAL ENGINEER 3/5/19 No. 9073281 JACOB D. SMITH STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

1500 0 1500

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	7/13/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES; COMBINE 7-2A,B,C DRAWINGS
2	4/18/2017	V.M.	B.R.	GREENS HOLLOW
3	10/18/2017	B.B.	B.R.	Add 4R4E Panel
4	3/27/2018	V.M.	B.R.	GREENS HOLLOW TECHNICAL ANALYSIS
5	10/31/2018	V.M.	J.G.C.	ADDED PROPOSED MINING IN PINES EAST AND SOUTH FORK WITH PROPOSED LEASE
6	1/15/2019	V.M.	J.G.C.	RELOCATED SPRING 94-591

PEN TBL: _SInd-SUFDP1.ctb
SHT SET: ####
PROJECT NUMBER: ####

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597 South SR 24 – Salina, UT 84654
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(435) 286-4499 Fax

SURFACE AND GROUNDWATER RIGHTS–QUITCHUPAH TRACT

SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
1" = 1,500'	07/13/2016	J.G.C	V.M.	V.M.	PLATE 7-2

FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 7-2.dwg

JohnSorensen: 1/17/2019 10:01 AM

GREENS HOLLOW LEASE

SITLA MUDDY LEASE

QUITCHUPAH LEASE

PINES LEASE

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

NOTES:

1. HISTORIC STREAM, SPRING AND WELL MONITORING SITES ARE OLD BASELINE MONITORING SITES OR SITES THAT HAVE BEEN DISCONTINUED OR MINED THROUGH THAT ARE NOT CURRENTLY BEING MONITORED.

EXPLANATION

- SUFCO MINE EXTERIOR LEASE BOUNDARY
- SUFCO MINE INTERIOR LEASE BOUNDARY
- 100000 MC — MINE COORDINATES
- 2020000 SPC — STATE PLANE COORDINATES
- HISTORIC STREAM
- STREAM MONITORING
- HISTORIC MONITORING WELL
- MONITORING WELL SITE
- HISTORIC SPRING MONITORING SITE
- SPRING MONITORING
- UPDES MONITORING POINT
- IN MINE MONITORING SITE
- (7600) ELEVATION OF SITE
- PERENNIAL FLOW LOCATION MONITORING POINT
- PERENNIAL FLOWS
- SPRING NOT MONITORED

Pines East Panels 3/29/19

The underground mining for these panels will be first mining (room and pillar). The mining plan for the Pines East Panels within the Pines Lease has no projected subsidence and no planned monitoring.

PROFESSIONAL ENGINEER 3/5/19 No. 9073291 JACOB D. SMITH STATE OF UTAH

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

1000 0 1000

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
19	7/14/2016	V.M.	J.G.C.	ADD GREENS HOLLOW & SOUTH FORK LEASE BOUNDARIES
21	12/15/2016	V.M.	T.L.M.	REMOVED SOUTH FORK LEASE BOUNDARY
22	4/12/2017	V.M.	J.G.C.	GREENS HOLLOW
23	9/19/2017	V.M.	B.R.	ADD PINS NOTATION
24	12/8/2017	V.M.	B.R.	ADD 4R4E PANEL
25	12/18/2017	V.M.	J.G.C.	ABOVE AMD BELOW
26	1/15/2019	V.M.	J.G.C.	ADDED MONITORING POINT NW4-09

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(435) 286-4880 Phone
(435) 286-4499 Fax

HYDROLOGIC MONITORING STATIONS

PEN TBL	SCALE	DATE	DRAWN BY	ENGINEER	CHECKED BY	SHEET NO.
_ISIdd-SUFDIP1.ctb	1" = 1,000'	10/26/2006	JMB/TRB	J.D.B.	V.M.	PLATE 7-3
SHT SET: ####	PROJECT NUMBER: ####	FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 7-3.dwg				

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GREENS HOLLOW LEASE

SITLA MUDDY LEASE

QUITCHUPAH LEASE

PINES LEASE

Pines East Panels 3/29/19

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NOTES:

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EXPLANATION

- PROPOSED LEASE BOUNDARY
- SUFCO MINE EXTERIOR LEASE BOUNDARY
- SUFCO MINE INTERIOR LEASE BOUNDARY
- 100000 MC — MINE COORDINATES
- 20020000 SPC — STATE PLANE COORDINATES
- UPDES MONITORING POINT
- STREAM MONITORING
- (7600) — ELEVATION OF SITE
- MONITORING WELL SITE
- PERENNIAL FLOWS
- SPRING MONITORING

1000 0 1000

I CERTIFY THE ITEMS SHOWN ON THIS DRAWING ARE ACCURATE TO THE BEST OF MY KNOWLEDGE

PROFESSIONAL ENGINEER — No. 9073201 — JACOB D. SMITH — STATE OF UTAH — 8/5/19

REVISIONS				
NO.	DATE	REQ. BY	DWG. BY	REMARKS
1	9/20/2017		B.R.	ADDED PINES NOTATION
2	12/18/2017		B.T.N.	REMOVED SPRINGS
3	3/14/2018	V.M.	B.R.	UPDATE MONITORING POINTS
4	3/27/2018	V.M.	J.G.C.	GREENS HOLLOW TECHNICAL ANALYSIS
5	10/31/2018	V.M.	J.G.C.	ADD SOUTH FORK LEASE PROPOSAL
6	1/15/2019	V.M.	J.G.C.	ADDED MONITORING WELL NW4-09

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

OPERATIONAL HYDROLOGIC MONITORING STATIONS

PEN TBL:					
_STndrd-SUFDEP1.ctb					
SHT SET:	PROJECT NUMBER:	SCALE:	DATE:	DRAWN BY:	ENGINEER:	CHECKED BY:	SHEET NO.
####	####	1" = 1,000'	8/15/2017	B.T.N.	J.D.B.	V.M.	PLATE 7-10
FILE NAME: H:\DRAWINGS\MRP\PLATES\PLATE 7-10.dwg							

johnstenson 1/17/2019 12:12 PM